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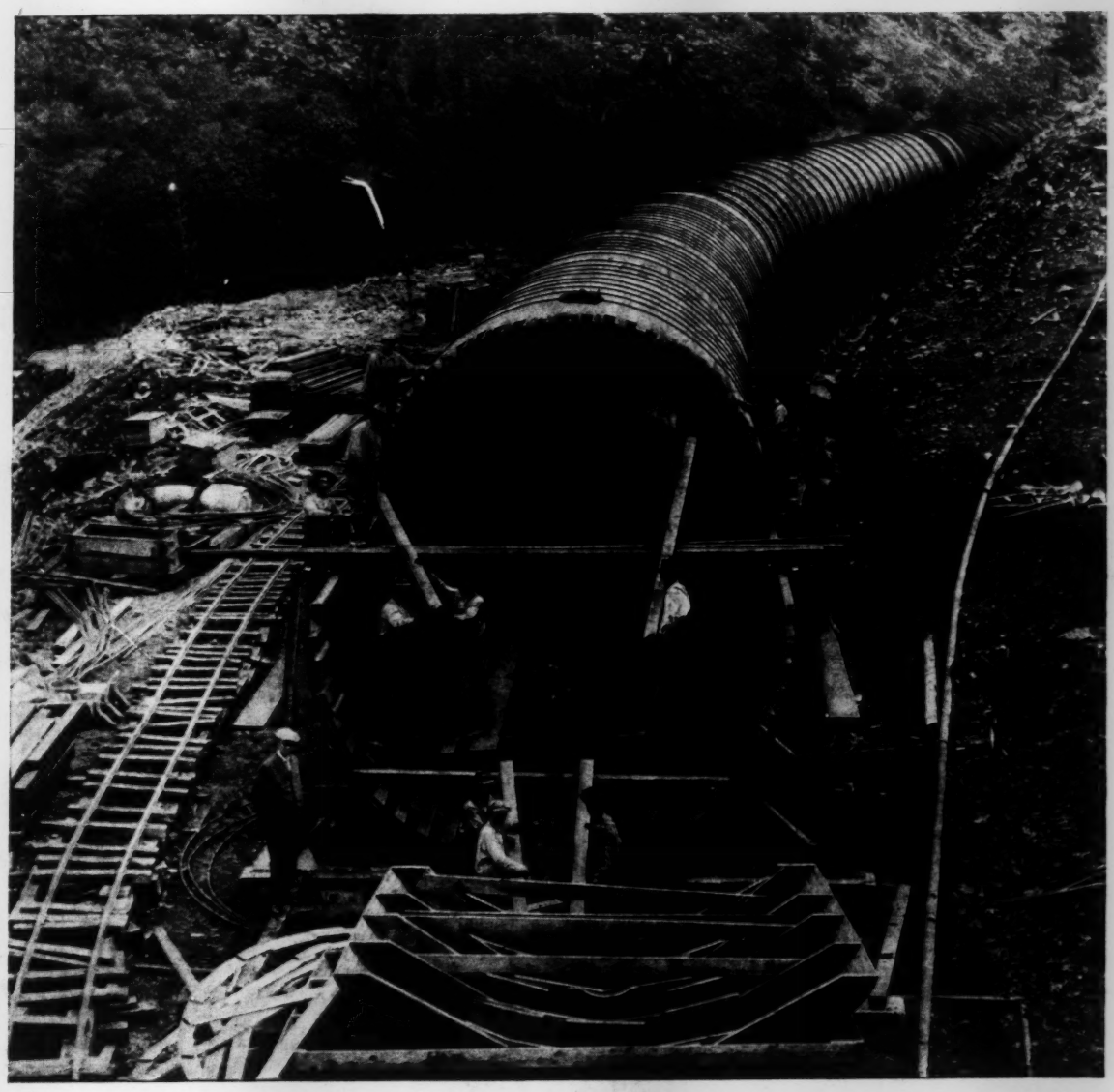

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Problems of a Deep Caisson-Cofferdam Foundation

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 96 NEW YORK, APRIL 15, 1926 Number 15

The New Chief of Engineers

BRIG.-GEN. EDGAR JADWIN will adequately fill one of the most important engineering positions in the country, that of chief of engineers of the United States army. He has had a long and varied experience, not only in the arts of peace, practice in which falls to all engineer officers, but in the art of war, the pursuit of which, fortunately for the world if not for the profession of arms, few officers are called to direct. The combination is one most necessary for the successful conduct of his new office, into which he will take the good wishes of his civilian professional friends and of his military professional associates.

Gasoline Taxes Grow

GASOLINE taxes in 1925 paid $102,065,216 toward state road improvement and $32,721,704 toward the improvement of county and township roads. The total gasoline tax income was $146,025,940 so that after taking out $217,393 for expenses of collection there was diverted to other purposes than road improvement $11,021,627. The diversion of over an eighth of the tax removes it in just that proportion from the field of the highway tax into the general revenue producing class and by the same token affects any argument for or against the tax as a principle. If one stands with the bulk of the authorities that a tax laid on a public service should be applied exclusively to that service this diversion may be criticized but otherwise few can oppose the tax. In particular, one can comment only favorably on the small collection cost. In general, the figures reassert the popularity of the tax, the average rate has increased to 2.26c. a gallon and more states than ever before are imposing a tax. Only four states have no gasoline tax but they are important states—New York, Illinois, Massachusetts and New Jersey—and have an enormous motor vehicle traffic. Prophecy is mostly a futile activity but one may be fairly confident that the gasoline tax will in a few years be universal in America. It has only one dangerous foe. The car owner will be satisfied to pay his ten or fifteen dollars a year extra for motor vehicle fuel only as long as he has confidence in the integrity of the highway officials who are intrusted with its expenditure.

Special Study Abroad

IN THE old days no young man's education was complete until he had taken the "Grand Tour"—which meant a leisurely year traveling around the world centers of art, science and society. If tales be true the last named of the three gained most attention and mankind, of both sexes, was considered the most important of man's studies. They are ordering things better today. In the news section of this issue is noted the summer art course of New York University in Paris. With its novel features of low cost, European professional assistance and collegiate credit here for work done abroad, the idea is worth considering by our engineering schools. It is true that this country has more to learn of Europe in art than in engineering, but a summer of real study and observation in and around some engineering center in England or the continent would give our American engineering students a broader view of engineering practice which should be very serviceable in their future work.

Peru Builds a Superhighway

THE road from Lima to Callao in Peru described in this issue is a distinctively exceptional structure judged by advanced trunk line highway practice in the United States. By South American standards it is a superhighway. The description makes this characterization very clear and it should not be forgotten. The instances where such a thoroughfare is warranted are few south of the equator, even fewer than are the instances where superhighways are warranted leading out of great North American cities. Materials and processes and equipment used in building the four-lane road from Peru's capital to its chief seaport are not those that South America's highway-development necessities require. The road building requirement there is not the paved road and its high type construction plant; it is mileage of earth road grades surfaced with the better local soils and the tools that the earth mover uses. It is important that, in the United States, we keep this difference in mind if we are best to serve our sister republics to the south in working out their public roads ambitions.

Real and Theoretical Efficiency

CRITICISM of construction efficiency in road building is getting into the newspapers through the studies being made by the Bureau of Public Roads. It is not unnatural that there is misinterpretation. Technical distinctions are not easily perceived by the non-technical. To point out that studies of a number of operations show actual efficiencies only a half or two-thirds the assumed theoretical efficiency seems to the layman editor little different from asserting that from a half to a third of the cost of road construction is wasted. At least some of them have so interpreted the meaning, though what the federal road investigation intended to convey was that there is a lag in actual total efficiency behind what would be theoretically possible if every element in the construction scheme functioned perfectly. Nevertheless, the road contracting business is bound to feel a little affronted. The hand of the day-labor advocate they feel is strengthened. A business as a whole has been indicted, they think, when what has been really shown is merely a comparative

productiveness, as compared with an ideal impossible to reach in an imperfect world. They resent the assumption that possible production output is a measure of costs and intelligent business management. True these distortions of the facts found by the federal road engineers are not the acts or intention of these engineers but they prevail and are not easily disproved. It would be worth while if it could be made plain that this work of the Bureau of Public Roads is an interpretive technical study of value and that it upholds the contracting business in its contention that efficiency and economy in contract road building do not follow the condition that a surety bond can be had for full performance.

A Supernumerary Water Board

A WATER supply board limited so largely to mere advisory functions as is the one proposed in the current bill authorizing Albany, N. Y., to spend $12,000,000 for an additional water supply is a departure from American custom. The Albany bill would create a construction board, with little but recommendatory powers, the final authority in all but the appointment of its engineering and other staffs being vested in the city board of estimate and apportionment. Although positions on many of the old boards, with their large burdens of responsibility, carried only nominal salaries the three members of the Albany board would be paid $5,000 a year each for five years or $75,000 altogether. This is liberal compensation, considering that most of what the members would probably be called upon to do would be to pass on, for acceptance or rejection, the recommendations of their chief engineer as to source of supply, specifications, contract awards and any contingencies arising during construction. The board has so little power as to raise question as to its justification.

A New Municipal Obligation

THE closed saloons and the ubiquitous automobile have combined to make the need of public comfort stations imperative. This has been recognized in various ways and places, but not in state legislation, with one exception, so far as we know. In 1919 the Wisconsin legislature passed an act requiring every incorporated city or village to provide and maintain a sufficient number of suitable and adequate comfort stations to serve the needs of both sexes. Under that act 89 cities and 59 villages have 210 comfort stations in use, while two more are under construction, and 27 cities and 14 villages are contemplating the provision of stations. In addition an "incomplete list" shows 426 gasoline filling stations with public toilet facilities, while another such list includes 99 park stations (summer only). Then there are 137 public rest rooms, which presumably serve the same general purpose. Wisconsin seems to have been in the lead for six years in making the provision of comfort stations a duty incumbent on every incorporated city and village within its limits and, to its credit also, of not leaving the law to execute itself but entrusting its enforcement, in some degree, to its State Board of Health. Other states would do well to consider the Wisconsin statute and its administration. The country-wide lack of comfort stations under sufficient state and municipal control to ensure adequacy in numbers and facilities, sanitation and decency, is a reproach to a civilized people which will increase daily until properly remedied.

The God Out of the Machine

FOR about a century the world has been living in the industrial age. It started with the invention of the steam engine and it carried through with myriad applications of that power, and of electricity, to the machines that man made. The whole economic progress of society has been multiplied many fold in this short hundred years over the steps it had made in the hundreds of centuries that went before. The world today is a mechanistic world where man is the tender of machines and not the individual creator. That this has made a more livable world none can deny. The standards of life are immeasurably higher; men work fewer hours and have more wants satisfied better than ever before. And yet man's wants are far from satisfied, though the machines continue to turn out things in such abundance that every so often the world suffers from what we call "overproduction."

For years this phenomenon of overproduction has engaged the attention of economists. It has been noted as the cause, or at least the superficial manifestation of a cause, for our industrial and financial depressions. The machine driven factories working strenuously to supply boom-time needs overrun the capacity to absorb and the industrial machine has to halt until consumption catches up, and there results a whole train of social and economic disaster. This is called overproduction. But it may be called, with better appreciation of what it entails, by the reverse term, that is underconsumption.

Consider where the development of the machine has brought us. So perfect has it become and so perfected the details of its application that we can make anything we want to, in any quantity we want to. The war showed that. Take ships. The Allies had to have ships. The industrial world organized, and ships came in such plethora that even now eight years after they rust and rot in our harbors. So with all the war needs. Production of any needed thing has no limits. And the more of the needed thing we make, the cheaper it is to make any one of those things. Mass production means cheaper units. But there is a catch in this utopian release from want; there is a limit to the consumptive capacity of the world.

We have shifted our point of attack with the development of the machine. Instead of having to perfect new means for production we must create new demands. We must make those want and need who have never wanted or needed. Advertising and selling become the crucial elements of industry and international struggles tend to shift from the age long craving for new land to a seeking for new markets wherewith to consume the increasing production that the philosophy of the machine imposes. Agriculture and mining, the wresting from earth itself the raw necessities of life, being only partly amenable to the law of increasing production and lower cost, become of secondary importance to both man and nation and those who serve them suffer in comparison with those who serve the machine.

This, then, is the dilemma of the machine. Many people are studying it, and their cogitations are worth considering. Two books recently published are especially interesting. One, a volume of Dutton's new "Today and Tomorrow Series," is called "Ouroboros, or the Mechanical Extension of Mankind," by Garet Garrett, a financial writer of standing. In an hour's time the reader may from this little book get food for many

hours' thinking. The other is by William T. Foster, lately president of Reed College, and Waddill Catchings, a business man of wide experience. This book, published by the Pollak Foundation, of Newton, Mass., is called "Profits," and while its theme is much broader it, too, sets up as the basis of its argument this requirement for an increasing consumption to satisfy the economic needs of increasing production.

Engineers, particularly, will do well to read such books and study the problem they pose, not because either one will help them to do better the particular job of the hour, but because engineering is primarily the science of production, and if this production is becoming a Frankenstein monster setting out to devour us, it is time those who have created it should take thought.

State Control of Garbage Disposal

OPPOSITION to sites chosen for garbage and refuse incinerators is a factor to be reckoned with. The engineer proposes an "ideal" site; the vicinage protests; the city council wavers, weakens and yields; the process is then repeated or the project abandoned, at least temporarily. Hopes for an "ideal" site decrease. The choice becomes more and more one of remoteness, which means increased haulage, very likely over poor roads for a considerable part of the way. As time goes on, in the case of a large city, the chances for several district plants, each at a district center, decrease until at best off-center locations for most of the district plants and at the worst a single incinerating plant, perhaps far to one side of the city, is the best that can be expected, with long hauls for much of the waste. If a location outside the city is proposed the hauls are lengthened and the opposition may increase in effectiveness if not intensity, for while the neighborhood population concerned may be small it is likely to have official support from the town and perhaps the county government. In any case, there may be lawsuits, private for intramural sites and both private and public (i.e., town or county vs. city) for extramural sites.

Notwithstanding all these difficulties, public disposal of city garbage and refuse is imperative, or is rapidly becoming so—even in the smaller cities. What is to be done? The way may be made smoother by careful engineering surveys and plans before the site is chosen, but that will not prevent blockades in many instances. A plan worthy of consideration is to require state approval of plans and sites for refuse disposal plants. This would not prevent neighborhood pressure on city authorities to prevent the use of sites within the city, but it should silence or weaken the objections and lighten their effect upon the city council. For sites outside the city, state control might supersede town or county jurisdiction where either exists. Right of court appeal would remain, whether the sites were in or out of the city, but the nature of the appeal and the admissability of evidence might be changed in at least some degree when plans and sites had already been approved by a state administrative board, after opportunity had been given for objectors to be heard.

The proper state authority to pass on plans and sites for garbage and refuse disposal works should be determined according to expediency in each state, considering that although this control has little relation to public health yet the general public strongly feels that it is a public health matter and probably it and the legislators and state administrative officers as a whole would expect to see the state department of health given jurisdiction. That very few state health departments are charged with any degree of control of garbage disposal, except under their broad health powers, and that few if any of them desire to add to their troubles in this way, is significant.

The need for state control is less a matter of public health than of municipal efficiency and economy and state legislation on the subject, including the choice of the jurisdictory body, should be framed accordingly. Account should be taken of how far our states are warranted in going into attempts to control municipal efficiency and economy. Doubtless least trouble would be experienced at the outset if state control of garbage and refuse disposal were added to the similar control of sewage disposal now vested in a large percentage of our state health departments.

Charging Properly for Public Money

MONEY breeds money, but the reverse is equally true. It costs money to get money. Private business knows this and takes it into account. Public administrators of course know it, too, but how rarely do they make proper allowance for it in their statements of cost. This question is suggested by a letter from Mr. Grunsky on power costs under the Hetch Hetchy water supply and power project of the city of San Francisco and by Mr. O'Shaughnessy's rejoinder, both appearing elsewhere in this issue.

The Hetch Hetchy project has been in progress for many years. It will be many years more before what was supposed to be the main object of the project, the delivery of Tuolumne River water in San Francisco, is accomplished. Meanwhile interest charges on capital outlay are piling up. Already they must be some $2,000,000 annually and before a drop of water from behind the Hetch Hetchy dam reaches San Francisco the annual interest on the investment may be double that.

True, there are credits, as Mr. O'Shaughnessy brings out, particularly rental or an equivalent, for the bay portion of the pipe line, utilized by the Spring Valley Water Co., receipts from the Hetch Hetchy Railroad and from power plants, but there is no evidence of a complete accounting system, and particularly not of interest and depreciation charges. To make worse matters already bad enough, the Board of Supervisors (equivalent to city council elsewhere) is juggling the accounts by charging an undue portion of the cost of the joint water and power project to water supply, against the well reasoned advice of the city engineer. This, that official says, is designed to speed up construction that will lead to power utilization—an expedient that is likely to befog still further the issue of power against water supply development and throw questions of service costs into confusion.

An honest accounting system seems to be badly needed at San Francisco—not merely a proper distribution of cost between water supply and power but what should come first, a determination of the actual cost of this great enterprise. San Francisco does not stand alone in its failure to show the full cost of municipal enterprises. It would be fortunate for it and other cities as well if it and they were compelled by statutory requirements to maintain true accounting systems, as San Francisco has to do, though grudgingly, for its municipally-owned street railways.

Problems of a Deep Caisson-Cofferdam Foundation, New York Federal Reserve Bank

Great Depth Required to Accommodate Five Cellar Stories—Bracing of Cofferdam Complicated by Size of Site—Two Types of Permanent Bracing—Wedging Methods—Stress Transfer Checked by Strain Gage

By Carlton S. Proctor
Moran, Maurice & Proctor, Consulting Engineers, New York

TWO deep foundations of the caisson-cofferdam type were recently constructed in New York under unusual difficulties. They are worthy of record not only as embodying the farthest development of this type to date but also because of the methods applied and new information developed in their design and execution. In the first case, that of the Federal Reserve Bank, a 19-story structure on Nassau St., Maiden Lane and Liberty St., a number of new problems arose, and methods had to be devised for dealing with them. These methods were later applied in modified and fully developed form in the construction of the Barclay-Vesey Building, a 35-story office building of the New York Telephone Co., occupying the block between Greenwich and Washington Sts. from Barclay to Vesey Sts. The present article outlines the main features of the work on the Federal Reserve Bank.

At the time of its construction, the Federal Reserve Bank required the deepest excavation so far made for a building cellar, 85 ft. below high curb to subgrade for the lowest cellar floor and 62 ft. below groundwater level. Five stories had to be accommodated below grade, and the vault which this substructure contains is several times the size of the next largest previously built. Also, the average air pressure required in the pneumatic work involved in constructing the cofferdam around the site closely approximated the limit allowed under the state law. The method of supporting the side walls of the cofferdam, both permanently and during construction, was new in many respects.

Curb elevation at the site of the building varied from 30 ft. above mean high water datum (corner of Nassau and Liberty Sts.), to + 13.5 (at east end of the site), while groundwater level was at El. + 7. The general excavation subgrade was to be at El. — 55; and finished floor levels of basements *A*, *B*, *C*, *D* and *E* at El. + 14, —5, —21, —36 and —50.5, respectively. The building occupies the entire block bounded by Maiden Lane, Nassau St., Liberty St., and William St., with the exception of the narrow Montauk Building at the William St. end. The dimensions of the site are 365 ft. 4 in. on Liberty St., 83 ft. on the east end, 389 ft. 3 in. on Maiden Lane, and 153 ft. 5 in. on Nassau St.

Main Problems—With the space requirements of the bank dictating a cellar excavated to a depth of 85 ft. below high curb over the entire area of the site, the first major consideration of design was that of lateral support for the cofferdam wall, both temporary and permanent. With the Mutual Life Building exerting a severe surcharge from the south and with the probability of serious damage to this building resulting from any appreciable movement of the south wall of the excavation, the problem of north-and-south support during construction required careful planning, but with a lot over 365 ft. in length the problem of temporary support in the east-and-west direction required that the temporary bracing design necessarily depart from previously used methods. The compression and make-up at joints of timber braces 365 ft. long would have been so great as to have probably caused serious movement in the Nassau St. wall and might have involved serious movements in the normal intersecting braces, regardless of the care taken in the supporting and lateral bracing of the timber system. The east wall could readily be supported by diagonal bracing to the north and south walls, but at the Nassau St. wall, 153 ft. 5 in. long, this system was impracticable.

Similar problems were confronted in the design for provision of permanent support for the cofferdam. The shape of the site (long and narrow) and the requirements of the building were such that the elevators and ventilating shafts were necessarily banked in two long aisles running east and west, and as the elevators and ventilating shafts ran through to basement *E*, these banks resulted in cutting each substructure floor continuously from the vault to the east end of the site. In addition to the shaft openings, the boiler room and coal bunkers seriously cut into the basement *C* and *D* floors. It was therefore impossible to support either the Liberty St. or Maiden Lane wall by the floor slab, since this would be continuously cut.

The design of the permanent support of the Nassau St. wall also required a departure from precedent due to the impracticability of carrying the pressure against this wall through to the east wall.

The second major influence on the substructure design was the size and location of the vault. This vault was to cover an area of approximately 11,500 sq.ft. and contain five stories, extending the full length of the site on Nassau St. and eastward from Nassau St. an average distance of 77½ ft.; as later appears this vault structure was to offer the solution of the Nassau St. wall support.

Preliminary subsoil borings had indicated bedrock at elevations varying from —42 to —66, and had disclosed the fact that waterbearing quicksand overlay the rock bed. The borings also indicated considerable irregularities in the rock surface contours, surface elevations varying as much as 15 ft. in a horizontal distance of 40 ft.

Dividing the Excavation—Fig. 1, showing the foundation layout, indicates the location of the vault and of the caisson cross wall separating the vault area from the cellar space proper. The determination to build the vault crosswall by pneumatic construction was the first step in the design. This served two purposes: (1) It fitted the vault design, which required such a wall for structural and protective purposes, and (2) it permitted the site to be divided into two definite areas of operation. Furthermore, the lease terms on the buildings which were to be wrecked were such that the buildings on the vault area would be vacated and wrecked some three months in advance

of the wrecking for the balance of the site. On this basis, a foundation plan was developed which required that the area within the vault cofferdam be completely excavated and receive its permanent lateral support before excavation should start on the balance of the site (except at the extreme east end).

For reasons previously outlined and for the additional reason that the vault crosswall, which must temporarily receive the Nassau St. stresses through the timber bracing, must be relieved of such stresses before the abutting subsoil behind it could be excavated, it was necessary to carry the support of the Nassau St. wall permanently to the Maiden Lane and Liberty St. walls. The vault plan required very heavy floors and roof, the former because of the extreme live-loads to which these floors would be subjected and the latter as a part of the protective requirements; and these floors were designed to carry the Nassau St. pressures at each floor level to the Maiden Lane and Liberty St. walls. It was of course impossible to conceive of such large slabs, cut by columns and floor steel, acting as girders; and they were therefore designed to act through direct diagonal compression.

The Nassau St. stresses thus carried through the various floors were as follows, from basement *A* to basement *E* respectively: 14,000, 31,000, 47,000, 67,000, and 50,000 lb. per linear foot of Nassau St. wall.

Lower Basement Floor—The basement *E* floor of the vault was designed to support a total unit load of 11,000 lb. per sq.ft., which included a live-load of 10,000 lb. per sq.ft. This unusually high unit live-load provided for the use of the entire floor for the storage of gold bullion. Because of the very high hydrostatic head which would develop under this floor unless it were drained and because such head would exist at times when the floor would be unloaded, it was necessary to provide a drainage course beneath the floor. The inclusion of the drainage system in the design for this floor precluded the possibility of carrying the floor loads to the rock floor of the excavation, and the ratio of unit load to span distance between piers precluded the possibility of girder action in a supporting slab. This floor system was therefore designed as a series of concrete arches supported by the concrete piers, which extended to rock.

Bracing of East Cofferdam—In the longer cofferdam outside of the vault, the temporary support was provided by 12 x 12-in. timbers in a north-south direction, while the east wall, being short, was supported by diagonal timbers to the Maiden Lane and Liberty St. walls. At the time when this timber bracing was installed, the vault crosswall required no support, since at this stage of the construction the vault floors had been completely installed and were transmitting the Nassau St. pressures by diagonal compression to the Maiden Lane and Liberty St. walls, thus relieving the crosswall of all lateral pressures. The permanent support for this area above the basement *E* level was provided in north-south direction by heavy steel struts which were so placed as to run in the narrow spaces between the shaft openings through the floors. Basement *E*, being substantially a continuous slab and of sufficient thickness, was designed to resist all lateral stresses at its level. Against the east wall, triangular slabs were cast at each floor level above basement *E* against diagonal steel struts so as to carry the east wall stresses into the Maiden Lane and Liberty St. walls. The permanent steel cross-lot struts were designed to transmit lateral stresses between opposite caissons, which stresses varied from a minimum of 200 tons to a maximum of 705 tons per strut.

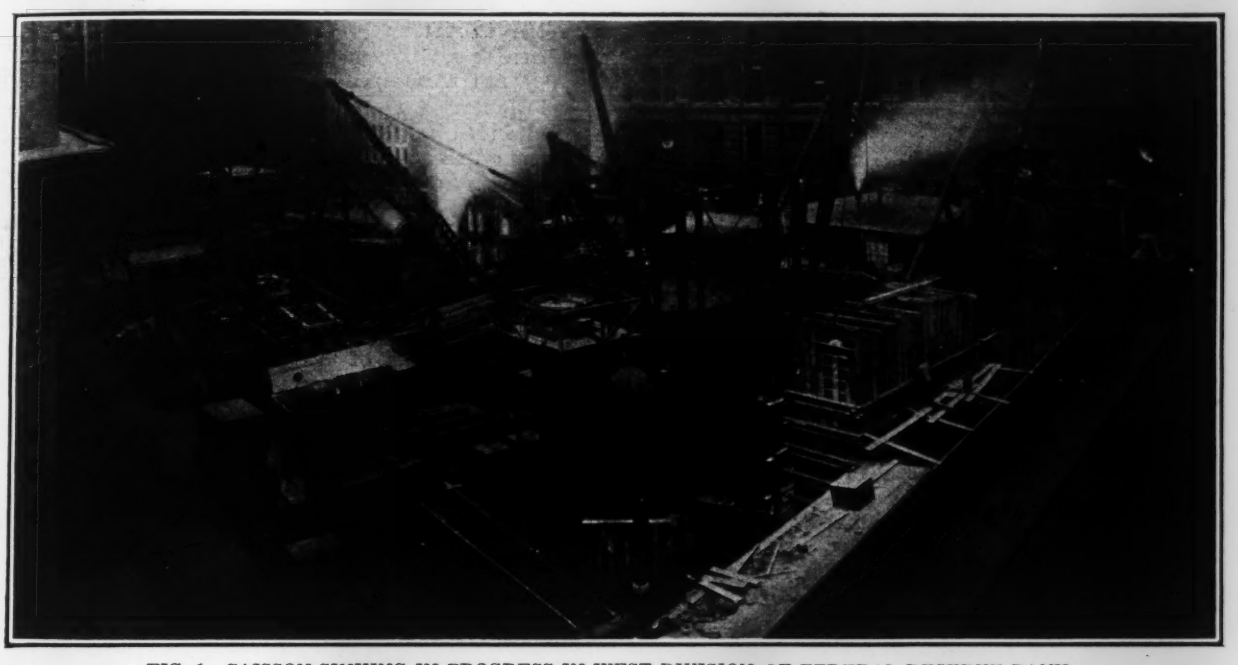


FIG. 1—CAISSON-SINKING IN PROGRESS IN WEST DIVISION OF FEDERAL RESERVE BANK
In east division the subgrade walls and footings are being removed

Caisson Conditions—These systems of permanent lateral support for the two cofferdams required special caisson designs to permit each caisson to meet its particular system of support. Caissons 1 to 10 and *A* to *D* comprised the vault cofferdam. For the vault floors to function as designed, it was necessary to form the caissons with serrations and pockets and to

build in special reinforcement placed with reference to the planes of the caissons which would (after sinking the caissons) correspond to the vault floor levels. Also in the longer cofferdam outside of the vault, in order that each caisson deliver its lateral pressure to its permanent steel struts, it was necessary to pre-

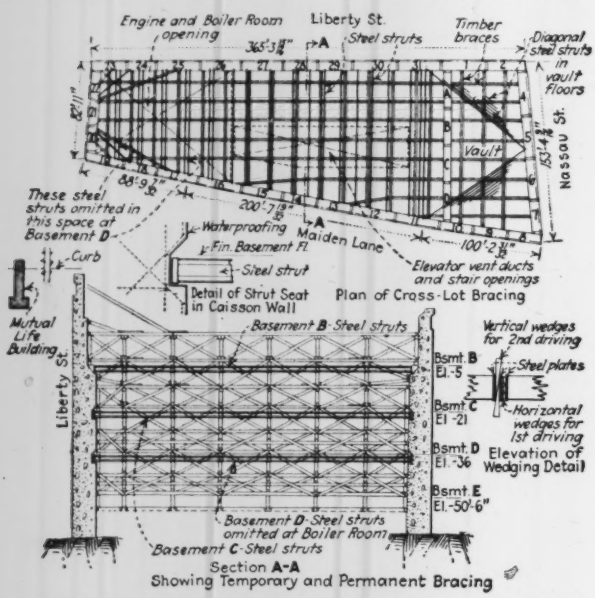


FIG. 2—BRACING PLAN AND SECTIONAL VIEW OF EAST DIVISION

West division, or Nassau St. part, braced by diagonal struts from west wall to north and south walls, embedded in heavy concrete floor slabs.

cast pockets into each caisson to receive the strut billets and to reinforce each caisson with distinct reference to the location at which each of its struts would bear.

In order to meet these conditions of caisson design with reference to caisson support, it was necessary first to predetermine the elevation at which the cutting-edge for each caisson should stop, and to require that every provision be made during sinking to meet this requirement. Such predetermined cutting-edge elevations were arrived at by the information as to rock levels available from the boring data.

Stressing the Struts—Where supported by struts, the calculation of the stresses in any caisson must of

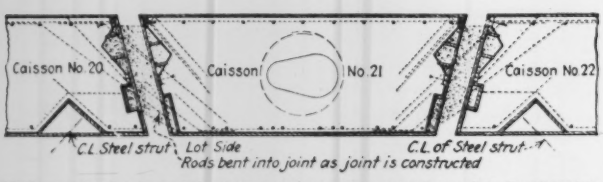


FIG. 3—DETAILS OF SPECIAL JOINT, EAST WALL CAISSONS

course be based on the assumed reactions which the struts would ultimately offer. Were the struts to receive their stress by an inward movement of the cofferdam walls, the determination of the ultimate stresses in such a system of yielding supports would be totally indeterminate, as would be the determination of the caisson stresses. Knowing that the stiffness of the caissons would result in piling up the stresses in the top tier of struts, which in turn would cause very high secondary stresses in the caisson reinforcement, a design based on such a system of strut stressing would demand the introduction into the calculations of a large factor of ignorance. In other words, had the steel struts been placed, riveted up, and the ends grouted into the walls so that they would have had a uniform bearing (as is the usual practice), when the timbers were removed the walls would have moved in, compressing the struts until the resisting forces, or stresses developed in the struts, were sufficient to resist further movement. With a thick, stiff concrete wall subjected to varying pressures, and receiving three sets of elastic supports, a fourth continuous rigid support (the basement *E* floor), and fixed at its base (keyed into the rock), the problem of determining the stresses in the wall is so completely indeterminate as to defy solution. To insure safety, therefore, excessively heavy struts would have been required, and when the temporary braces were removed it would have been found that many of the steel struts were carrying a stress much below that for which they were designed. On the other hand, were the struts installed in such a manner that they would exert a push against the wall just sufficient to balance the external pressures, the walls would not move when the timber bracing was removed, and the stresses in the struts should closely approximate those for which they were designed. It was therefore determined that the steel cross-lot struts would be pre-stressed by the use of steel wedges between billets built into the strut sections, such prestressing of struts to be completed prior to the removal of any of the temporary timber bracing. The caissons were then designed on the assumption of non-yielding supports and the reactions thus determined were the amounts of pre-stressing required for the struts.

An Unbraced Caisson—The support for the east end of the cofferdam was provided by diagonal steel struts and triangular slabs carrying the stress from the east wall into the Maiden Lane and Liberty St. walls. The boiler room space requirements and the space required for a stair well at the center of this wall were such that it was impossible to provide support for the middle of the three east wall caissons by the steel struts and triangular slabs. The underpinning requirements of the Montauk Building had precluded the possibility of using two long caissons for this wall and had dictated the sizes of the three caissons installed. To have carried the diagonal struts to a bearing on either end of the middle caisson would have cut into the boiler room and stair well to a prohibitive extent. It was therefore necessary to design the three east wall caissons for a concentration of support at about the three-quarter point on each end caisson at each floor level,

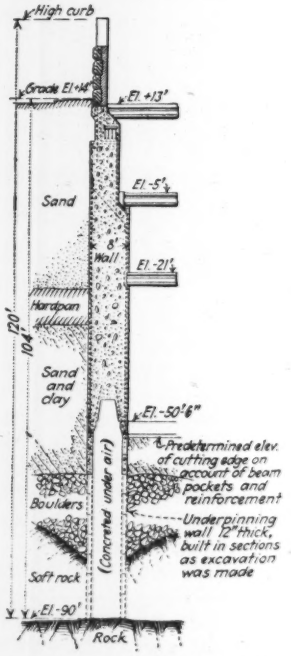


FIG. 4—UNDERPINNING A CAISSON

and for no direct support on the center caisson. To meet this condition the two end caissons were designed to cantilever beyond their points of support and to support either end of the center caisson through the two caisson joints. This required that special shear reinforcement be built into the caisson joints under air, and that the joints be constructed on a 45-deg. angle with the center line of wall, instead of normal to the wall line which is the method always previously employed. The center caisson was then designed for a simple span between supports at its ends.

Wedging the Timber Braces—At the earliest opportunity after the commencement of excavation within the vault cofferdam, a test was made to determine the amount of stress which could be developed by wedging in a 12 x 12-in. cross-bracing stick. Since it was important that there be no inward movement of the cofferdam walls in stressing the cross-lot timber, it was felt that possibly the limit of pre-wedging, and not the maximum allowable working stress of the timber, might control the temporary bracing design. The test was conducted by placing a special recording jack into the make-up of one cross-lot timber, placed as a unit in an entire tier. This tier of timber bracing was installed immediately on the soil. On the first test, a timber was stressed by the usual method of driving oak wedges, when it was found that at approximately 55 per cent of the allowable working stress of the stick the wedging ends of the stick began to split. The same test with the use of steel wedging plates showed an early failure of the oak wedges and a splitting of the wedged ends of the timbers. A further test using steel wedges and steel wedging plates caused a splitting of the wedged ends of the timber at considerably below the allowable working stress. In other words, it was demonstrated that by the use of the usual wedging methods it was impossible to develop a timber efficiently without permitting the walls to move in to deliver a considerable proportion of its stress.

A test was then made wherein a double system of wedging was used at each end adjacent to the caisson walls, and consisting of a vertical and a horizontal set of wedges at each end, both systems being driven between steel plates. By this method, a stress exceeding the usual allowable working stress was wedged into the sticks without any indications of overstressing.

The system employed was to develop about 40 tons stress in a 12 x 12-in. stick through the use of a set of wedges driven horizontally; after excavating to a depth of about 3½ ft. below the timbers a vertical set of wedges (which had been entered between their plates prior to the first wedging) was driven up to develop an additional 35 tons per stick. The initial stressing exceeded the stress which would be thrown into the stick due to a 3½ ft. depth of excavation and the final stressing of the stick equaled the total stress which would be thrown into the stick with the excavation carried to a depth to permit the installation of the next lower tier of braces. In this manner there was no tendency for the wall to move in to stress the timbers. Since the splitting of the timbers was the result of high concentrations at the end of the stick when each wedge was being driven, the double system of wedging produced a distributing medium of plates and the first set of wedges, so that a uniform stress at the end of the timber was developed when any single pair of wedges of the second set was being driven.

Caisson Joints—Prior to the construction of the Federal Reserve Bank, pneumatic cofferdam joints had been constructed by the installation of timber poling boards placed as the joint was excavated and calked with oakum. This method entailed additional hazards in joint construction over caisson construction, due to the low strength of the poling boards as compared with caisson reinforced concrete and due to the fire hazard involved. These considerations, exaggerated as they would be in joint construction to the depth required on this project, led to the design of a joint consisting of an inner and outer wall of reinforced concrete, which walls were constructed in 2-ft. vertical lifts as the excavation proceeded, each succeeding lift being hung by dowels from the previous lift. Both walls were anchored to the caisson on either side by reinforcement which had been built into the caisson ends for this purpose and was bent out into the joint as the joint excavation proceeded.

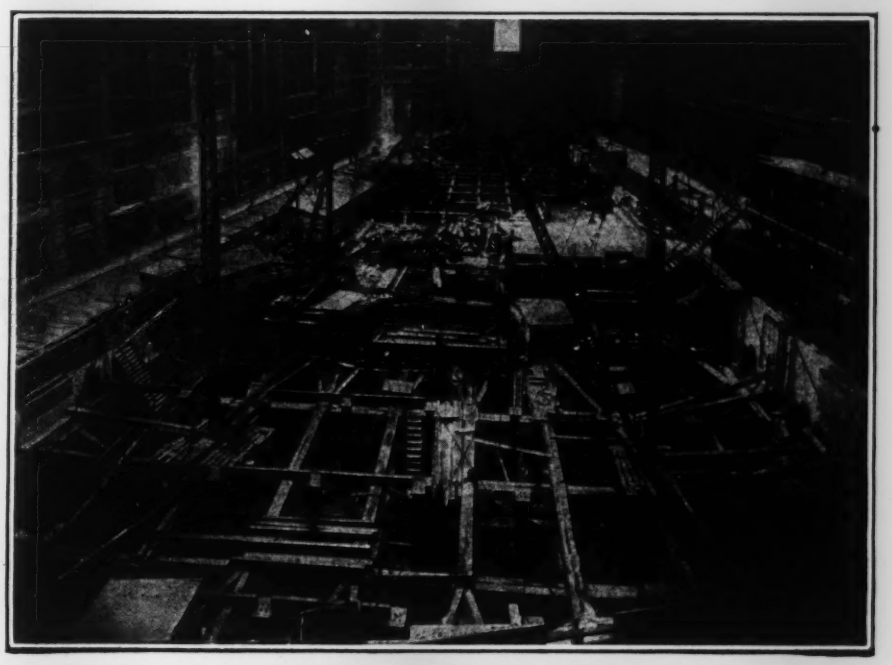


FIG. 5—VAULT FLOORS BEING CONSTRUCTED IN WEST DIVISION; EAST DIVISION READY FOR GENERAL EXCAVATION

Caisson Crosswall Moves—There were many interesting developments and problems which arose during the work of substructure construction. The vault section was the first to be excavated, and here, very soon after the start of excavation, difficulties arose in

supporting the Nassau St. wall. Curb level along Nassau St. was approximately 20 ft. above the grade level immediately to the east of the vault crosswall and the Nassau St. wall was supported on timbers bearing against the vault crosswall. This difference in grade levels resulted in a considerable unbalanced head against the vault crosswall which caused both the Nassau St. wall and the vault crosswall to start to move east. By placing about 700 tons of caisson weights on the soil just east of the crosswall, a head was developed to equal the unbalanced head and the movement immediately stopped.

In the vault section, bedrock averaged about 16 ft. below general excavation subgrade, and since the vault columns were extremely heavy the supporting piers to rock were large in horizontal section and covered 20 per cent of the vault area. The ground material between vault subgrade and rock bottom consisted of a compact formation of large boulders; and, therefore, to have excavated for these piers by the usual method of sheet piling and using one of the piers as a sump to drain the area would have destroyed the supporting value of the soil between subgrade and rock due to the loss of material back of the sheeting and to the loss of counterbalancing hydrostatic head, and would have overstressed the lower section of the caisson. Had an attempt been made to support the wall at general excavation grade, on the assumption of no support from the soil, a pressure of approximately 60,000 lb. per linear foot of wall would have required support on a temporary system. It was therefore necessary to excavate for the piers one at a time without the use of vertical sheet piling and to fill each pier with concrete as soon as it was excavated. In this manner the supporting value of the soil was not disturbed and there was no movement of the walls or indication of overstressing of the lowest section of the caissons.

FIG. 6—STEEL SUPERSTRUCTURE OF WEST DIVISION COMPLETED, AND STEELWORK OF EAST DIVISION STARTED

Irregular Rock Surface—Extreme irregularities were found in the rock surface contours. This meant that the predetermined levels for stopping the cutting-edges were, for many caissons, considerably above the actual low rock levels. The absence of hardpan over the rock required that the caissons be underpinned from the cutting-edges down to the lowest level of rock for each caisson, and the facts that the material at this level was in general a quicksand under a very high head and that the depth of underpinning was in some instances considerable, required that this underpinning be done with extreme care to prevent a blow-out.

Underpinning the Caissons—The most extreme instance of this caisson underpinning difficulty occurred in caissons 17 and 18 on Maiden Lane. Here the cutting-edge was stopped at El. —56, or 86 ft. below high curb; at the west end of caisson 17 rock was found at approximately this level; but a valley in the rock surface which the borings had not discovered carried the rock surface down to El. —90, or 120 ft. below high curb, in an east-west distance of 13 ft., a drop of 34 ft. at a slope of almost three to one. East from the low point the rock surface rose to El. —74 at the west end of caisson 18, and then ran through under this caisson approximately level. This meant that caisson 17 was underpinned for about two-thirds of its length to a maximum depth of 34 ft. below its cutting-edge and that caisson 18 was underpinned for its entire length to an average depth of 18 ft. No such operation as this had ever before been attempted and it is certain that it never will be attempted again if it can possibly be avoided. Even with the utmost precautions and with the most careful possible balancing of air pressures the risks involved were tremendous. A blow-out through the sand floor or working walls or an accident causing the sudden loss of even a pound of pressure might have caused the collapse of the walls. The pressure required to maintain this balance ran to a maximum of slightly over 50 lb. per sq.in., which indicates a hydrostatic pressure against the outside of the walls of 115 ft., or 7,200 lb. per square foot. In this case there was no alternative, since the predetermination of the ultimate cutting-edge levels was essential to the design, and since the borings, although made at frequent intervals around the site, had failed to disclose this condition.

In this underpinning the excavation was carried down 2 ft. at a time and the exposed wall protected by a 12-in. concrete wall before further excavating. Dowels driven downward into the ground before pouring the wall concrete provided means of bonding in the next lift.

Northward Pressure—Along Liberty St. the curb level averaged about 10 ft. higher than along Maiden Lane. This meant that a wall averaging approximately 20 ft. above the level of the first tier of timber bracing had to be supported by spur braces heeling against the first tier of timber. The unbalanced head due to the difference in curb levels together with the heavy surcharge exerted against the Liberty St. wall from the Mutual Life Building's floating foundations caused both the Liberty St. and Maiden Lane walls to start to move north. By carrying the spurs against the Liberty St. wall down through the timber system to a

heel against the floor of the excavation, and finally against the ultimate subgrade, this movement was stopped.

Permanent Steel Bracing—Caissons sunk to the depths required for this project will necessarily sink to varying degrees out of plumb, and may vary either in or out from the theoretic positions. For this reason, it was impossible to determine, in advance of sinking, the actual length of the permanent steel cross-lot struts; and to have waited until after the excavation was completed so as to have ordered the struts from actual measurements would have entailed a considerable delay in the installation of the substructure steel. By accurately plumbing the shaft after the cutting-edge

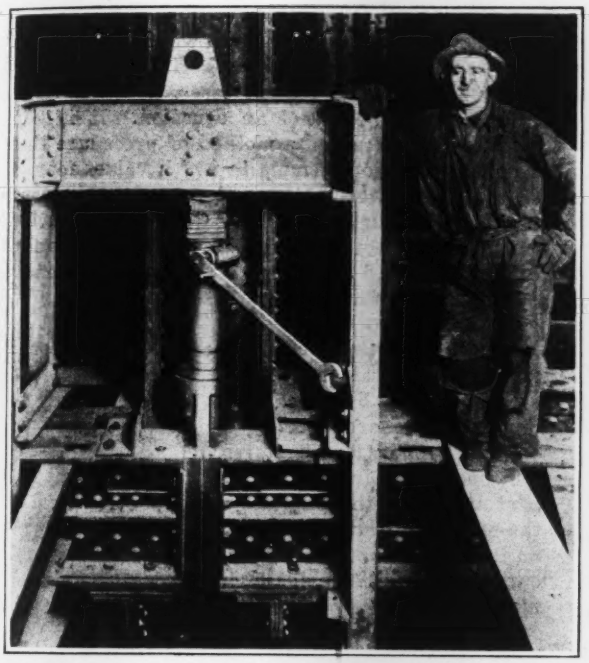


FIG. 7—WEDGING JOINT IN STEEL PERMANENT STRUT

had been landed and by surveying the top of the caisson, the position of each pocket at each floor was interpolated and the strut lengths thus determined for ordering purposes. Such interpolated distances were in every case within an inch of actual final distances.

Stresses Checked By Strain Gage—As noted above, the compression of the steel cross-lot struts was accomplished by the insertion of steel wedges. The wedging joints were located near the wall ends of each strut and the wedges were driven by the use of screw or hydraulic jacks and specially constructed wedging frames. At the wedging joints in the steel struts the sections of the strut butt against each other, tapering slots being provided for the wedges (Fig. 7).

The stresses in the struts were measured by an extensometer or strain gage. The stress in each end of each strut was carefully measured at least three times; just after jacking, just before taking out the adjacent timber bracing, and after taking out the timber bracing. A comparison between the final stresses (measured after the removal of timber bracing) and the stress when wedged in showed that in the majority of cases there was a reduction in the final stresses, although there were a number of struts in which the final stress equaled or exceeded the original stress. At least four factors contributed to the reduction in final stress; the readjustment of the loads carried by the various steel and timber struts supporting a section of wall as the adjoining struts were being wedged, the transfer of load from the timber struts to the steel struts as the former were removed, temperature changes, and lapse of time.

A series of measurements was taken at sections of the wall opposite high buildings on floating foundations to show the effect on the stress in any given strut produced by the wedging of adjacent struts; such measurements showed in general that the strut stress decreased as adjacent struts were wedged. At the same sections of the wall the strut stresses in many instances increased again when the timber bracing was removed. On the other hand, simila.' readings taken opposite low buildings or buildings whose foundations went to rock showed no material change in strut stresses during the wedging of adjacent struts and no increase in strut stresses when the timber braces were removed.

Tests of Temperature Movements—In the design, considerable thought was given as to the possible effect of temperature stresses in the struts, the question being whether the wall was too thick and stiff and the soil too firmly compressed to permit an outward movement of the wall when the strut temperatures materially increased. Should these factors prevent an outward movement of the wall and a consequent lengthening of the strut with an increase of temperature, the resultant stresses in the struts would be cumulative and might be considerable in amount. Definite allowances for temperature stresses having been made in the design, careful measurements were made to determine accurately the actual effect of temperature changes on the struts, most of the measurements being taken on struts opposite high buildings on floating foundations where the effect of surcharge would be the worst.

Holes were drilled into the struts through the cover plates and into the web, to accommodate a chemical thermometer. These holes were near the gage point and were filled with oil, the thermometer being inserted when the readings were taken. The measurements were made after all wedging had been completed and after all the timber had been removed so that the only probable factors which could cause changes in the strut stresses would be temperature changes and time lapse. These measurements clearly showed that whereas the stresses would increase with a sudden increase in temperature, the ultimate stresses, recorded after a sufficient lapse of time, were constant. This seemed to indicate clearly that the cofferdam walls at their point of support moved in and out the small distances required to accommodate the changes in strut lengths due to temperature changes, and that increases in strut stresses due to temperature increases were entirely of a temporary nature. The readings showed that for a drop in temperature the walls moved in almost as the temperature changed, but that with an increase of temperature the strut stresses would increase temporarily, the walls gradually moving outward enough to relieve this increase of stress.

A total outward movement of the walls of $\frac{1}{8}$ in. (permitting a total increase of strut length of $\frac{1}{4}$ in.) would accommodate the maximum variation of temperature during the readings. These results are of particular interest since the question as to whether a deep coffer-

dam could move outward is one which has long been discussed and since this is probably the first time that accurate measurements and readings have been made to determine this question. It has been rather generally felt that the pressure required for an outward movement near the bottom of a deep cofferdam would be considerably greater than the static pressure exerted against the cofferdam at the same point, due to the fact that a movement must take place and a slight compression of the soil result, and it has been generally believed that such movement and resultant soil compression would require a considerable increase of pressure. These measurements clearly indicated that for the small movements involved these assumptions were only partially correct and then only for a short duration of time, and that the increase in stress was gradually and totally lost with a lapse of time.

The readings showed that compared with the assumptions as to lateral pressure made in the design (which, if correct, would have resulted in an equal unit stress in all struts), the average stresses at the *B* floor level were the highest and *C* the lowest.

Each strut was stressed by the jacking in of wedges at either end at the same time. The question was raised as to whether the stress jacked in at the strut end distributed itself uniformly throughout the strut length or whether this action was prevented by the stiffness of the columns. To answer this question, two of the struts were wedged at one end only, readings being taken during wedging at the wedged end and at the opposite end and these readings indicated a unit stress in the end remote from the wedging point of only 5 per cent less than the unit stress at the wedged end, which after lapse of time became uniform.

Special readings were taken to determine the effect of the point of support on the distribution of stress throughout the cross-section of a strut. One set of readings was taken directly over a point of support and midway between two splices and another set was taken half-way between the point of support just mentioned and the adjacent point of support. The readings showed that whereas the distribution of stress through the cross-section of the strut was uniform, indicating that the influence of the point of support was negligible, the average unit stress in the strut directly over a point of support averaged about 13 per cent higher than unit stress at center of span.

Quantities—Quantities involved in the project were:

Caisson sinking	23,000 cu.yd.
General excavation (exclusive of caisson excavation)	100,000 cu.yd.
Concrete	29,500 cu.yd.
Reinforcement	1,017 tons
Cross-lot bracing timber	1,361,000 ft. b.m.
Total timber used on job	2,702,000 ft. b.m.

About 2,760,000 cu.ft. of substructure space was created. A 10,000-cu.ft. compressor plant was required to supply air for the caisson sinking.

Builders—The work was designed and constructed under the direction of York & Sawyer, architects, and was built by Marc Eidlitz & Son as general contractors. A. B. Trowbridge is consulting architect for the Federal Reserve Bank. Moran, Maurice & Proctor were the consulting engineers for the substructure design and supervision, and H. G. Balcom was the structural engineer. The Foundation Company executed the foundation contract.

Calculation of Continuous Beams of Variable Section

A Simple Algebraic Method Using the Area-Moment Principle Applied to Irregular Loading and Makeup

By Philip G. Laurson
Associate Professor of Engineering Mechanics, Yale University, New Haven, Conn.

By the method shown below, a simple application of the well-known area-moment principle, it is possible to obtain without calculus the three-moment equations for a continuous beam with variable modulus of elasticity E and variable moment of inertia I, and any system of vertical loading, however irregular. As here given the method applies to beams in which the supports are at the same level and offer no horizontal restraint, but it may be modified for other cases.

This is a method and not an equation. It is generally better to understand a method of procedure than to have an equation or formula in which values may be substituted. Three-moment equations are cumbersome for any but the simplest cases. One such equation, recently published, for the case of a single concentrated load in each span and variable E and I, contains sixteen integral signs. Unfortunately, these are terrifying to many engineers.

In order that the method may be well understood it is necessary to consider first the simpler case with constant E and I. For the benefit of any reader not familiar with the area-moment principle, one of the fundamental propositions is stated.

> *Proposition*—In a beam, originally straight and bent by loads, the distance (measured normal to the original direction of the beam) of any point A on the elastic curve, from the tangent to the elastic curve at any other point B, is equal to the statical moment, with respect to A, of the area of the M/EI diagram between A and B.

By the M/EI diagram is meant a diagram whose ordinate at any point is equal to the bending moment at that point divided by E and I of the beam at that point.

Consider two spans of a continuous beam, with constant E and I, and with any system of vertical loading on each span. The bending moment at any point in either one of the spans will obviously be the sum of (1) that which would result in a simple span from the given loading and (2) the bending moment at the same point due to the effect of the bending moments at the supports. We may draw a bending moment diagram for each span with the bending moments caused by the loads on a simple span and the bending moment resulting from the unknown bending moments at the supports represented separately. It might look like the M diagram of Fig. 1. Here the areas A_1 and A_2 are the bending moment diagrams for simple spans carrying the given loads, while the trapezoids below are the bending moment diagrams resulting from the bending moments M_A, M_B and M_C at the supports caused by the continuity of the beam. The reader will see that if M_A and M_B are the bending moments at the ends of a beam the resulting bending moment at any intermediate point will be equal to the ordinate to the straight line shown. The trapezoids may be divided into triangles by dotted lines for convenience in computing moments.

Let x_1 be the distance from R_A to the centroid (center of gravity) of A_1, and x_2 the distance from R_C to the centroid of A_2. Using the area-moment proposition, the deflection of the point on the elastic curve at R_A from the tangent to the elastic curve at R_B is

$$d_1 = \frac{1}{EI}\left(A_1x_1 + M_A \times \tfrac{1}{2}l_1 \times \tfrac{1}{3}l_1 + M_B \times \tfrac{1}{2}l_1 \times \tfrac{2}{3}l_1\right)$$

where the plus sign is assumed for the unknown bending moments M_A, M_B and M_C, though they have been shown below the base line for clearness. With this assumption the sign which results from the solution of the equations will be the proper sign. In the same way

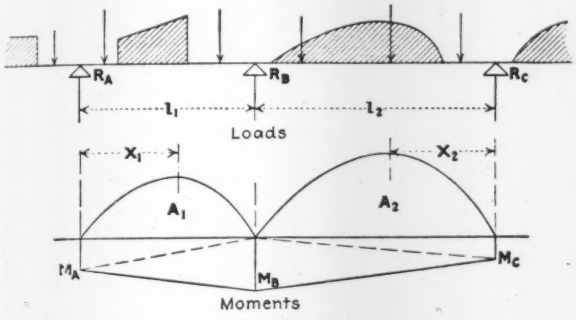


FIG. 1—MOMENT DIAGRAMS FOR TWO SPANS OF IRREGULARLY LOADED BEAM

the deflection of R_C from the tangent at R_B is

$$d_2 = \frac{1}{EI}\left(A_2x_2 + M_B \times \frac{l_2}{2} \times \tfrac{2}{3}l_2 + M_C \times \frac{l_2}{2} \times \tfrac{1}{3}l_2\right)$$

Since the supports remain on a horizontal line and there is but one tangent to the elastic curve at R_B, we know that $d_1 = -d_2l_1/l_2$, or $d_1/l_1 = -d_2/l_2$, or,

$$\frac{1}{EI}\left(\frac{A_1x_1}{l_1} + \frac{l_1}{6}M_A + \frac{l_1}{3}M_B\right) = -\frac{1}{EI}\left(\frac{A_2x_2}{l_2} + \frac{l_2}{3}M_B + \frac{l_2}{6}M_C\right)$$

from which

$$M_Al_1 + 2M_B(l_1 + l_2) + M_Cl_2 = -\frac{6A_1x_1}{l_1} - \frac{6A_2x_2}{l_2} \quad (1)$$

Eq. (1) is a very convenient form of the three moment equation, inasmuch as it will take care of any system of vertical loads. To write the equation for a given problem, it is only necessary to find A_1x_1 and A_2x_2, the statical moments of the M diagram for the spans drawn as for simple beams. If the loading is complicated and irregular the M diagrams may be divided into vertical strips and the statical moments of these strips summed up.

In passing it should be noticed that the special three moment equations for the simple cases of uniform loading covering each span or a concentrated load on each span are readily derived from eq. (1) by substituting the special values of A_1x_1 and A_2x_2 for either case.

What modifications may be made to care for variable E and I? In the first place, do not try to modify eq. (1), but work out the desired equation directly by deflections from the data of the problem. The relation $d_1/l_1 = -d_2/l_2$ still holds good.

Since EI is not constant throughout the two spans, we must use the M/EI diagrams instead of the M diagrams in writing expressions for d_1 and d_2. For the part of the diagram corresponding to A_1 and A_2 the procedure is obvious. Simply divide the bending moment at any point (as computed for a simple span) by EI for that point and plot this value as one of the ordinates of the M/EI diagram. The part of the diagram corresponding to the four triangles below the line will become four irregular figures. The height of each of these at any point will be the height of the corresponding triangle at that point divided by the EI at that point.

An example will illustrate the transformation of the M diagrams into the M/EI diagrams. In this problem instead of dividing by EI (a large cumbersome number) the divisors used were proportional to EI, which is all that is necessary. Thus 1.8 was used instead of 180,000,000 and 2.5 instead of 250,000,000.

Having the M/EI diagrams (or diagrams in which the ordinates are proportional to M/EI), such as the lower diagrams of Fig. 2, find the statical moment of the three areas for the left-hand span with respect to the left-hand reaction, and the statical moment of the three areas for the right-hand span with respect to the right-hand reaction. These are proportional to d_1 and d_2 respectively and may be substituted for d_1 and d_2 in the equation $d_1/l_1 = -d_2/l_2$, giving the desired

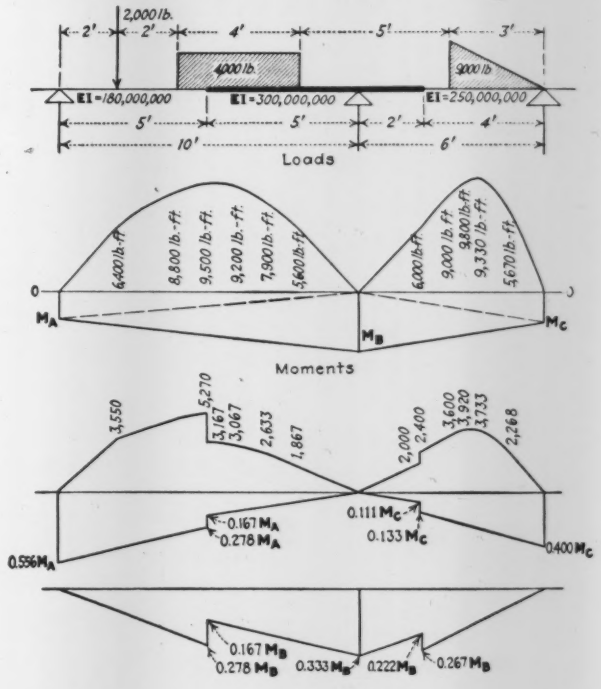


FIG. 2—BEAM OF VARIABLE SECTION LOADED IRREGULARLY

The three-moment equation for this beam reduces to $7.43\ M_A + 19.11\ M_B + 3.83\ M_C = -179{,}600$.

three-moment equation, which should be reduced to its simplest form. A corresponding equation is found for each pair of spans, and these equations are solved simultaneously for the values of the unknown bending moments at the supports.

If one of the two spans is an end span and there is no overhang nor restraint, the moment at the end reaction is zero, which means that one of the triangles vanishes. If there is an overhang at the end reaction the corresponding M_A or M_C has a known value which should be used in the M/EI diagram.

Nearly all textbooks on strength of materials give elementary and general treatments of continuous beams. Eq. (1) is given in Morley's "Strength of Materials."

Toledo Intercepting Sewers—II: Regulators, Siphons

Balanced Regulators Divert Storm Flow—Cast-Iron Siphons in Multiple—Tunnel Clay Excavated with Power Knives in Pilot Holes and Manholes Dug from Bottom

By Harvey P. Jones
With Fuller & McClintock, Engineers, New York and Toledo

The design of the Toledo intercepting sewer system was worked out after a comprehensive investigation of ground water conditions, the existing system, relation between domestic and industrial sewage, and probable 1960 population and area.

The results of this investigation and the general plan of the Toledo system were described in "Engineering News-Record" April 1, p. 526. A third article will describe the design and construction of the pumping station and outfall sewer.—Editor.

STORM water regulators of novel design, excavation of sewer tunnels with power knives through pilot hole enlargements and construction of manholes upward from the barrel of the sewer to the surface, are features of the Toledo intercepting sewer system, a general description of which appeared in the first article.

Storm Water Regulators—Practically all of the sewers within the city limits have been built on the combined plan. Regulating devices were required which would divert the dry-weather flow to the intercepters, control the quantity diverted at times of storm and prevent surcharging of the intercepters when the existing outlets are partly or wholly submerged during floods. Two types were designed and installed. Both types, differing only in mechanical construction, are controlled by the flow of sewage in the combined sewer. This method of control allows regulators to be located at considerable distances from the main intercepters. The mechanisms are designated either as revolving-gate or flap-gate type. The former type is used where large volumes and the latter where small volumes are to be diverted from existing sewers. The flap-gate type of mechanism is an adaptation of the valve made by the McNulty Engineering Co., of Boston, Mass.

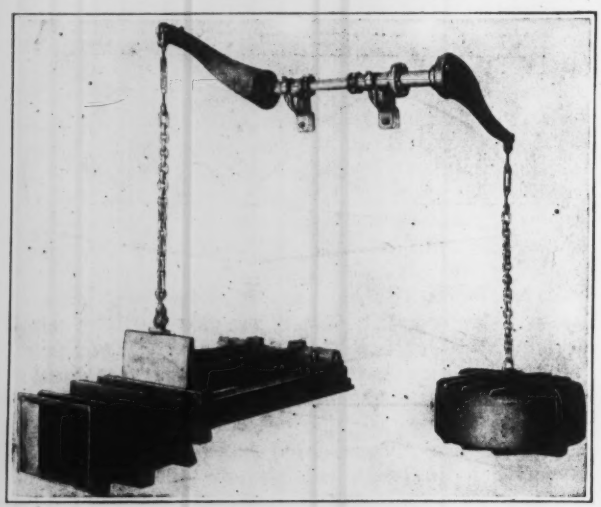


FIG. 1—REVOLVING TYPE OF STORM WATER REGULATOR FOR LARGE FLOWS HAS RECTANGULAR ORIFICE
Until sewage reaches a fixed weir level the gate is in wide open position but is gradually shut as sewage rises.

For both types the concrete regulating chambers in which the mechanisms are installed are of the same size and dimensions except for that portion which is on the line and grade of the existing sewer, which varies with the diameter of the existing sewer. The regulating chambers are built in three separate compartments. The weir compartment, which replaces part of the existing sewer, has a weir, with a crest at the height required to intercept the desired quantity from the existing sewer. The gate compartment contains the major portion of the regulating mechanism. The only connection between the weir and gate compartments is through an orifice opening made by setting a special casting in the dividing wall between these two compartments. The revolving-gate type has rectangular and the flap-gate type circular orifice openings. The float compartment, which adjoins the gate compartment, has installed in it the actuating float, which controls the movement of the gate in front of the orifice. The same level of sewage in both float and weir compartments is maintained by means of a cast-iron pipe connecting the two. Any movement of the float is transmitted directly to the gate by means of a shaft and system of levers.

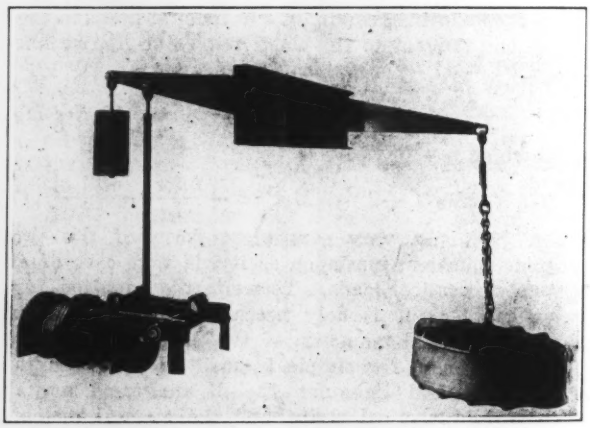


FIG. 2—FLAP GATE REGULATOR USED FOR SMALL VOLUMES OF FLOW

When sewage reaches the level of the weir crest the gate is in a wide open position. All the sewage is diverted through the orifice opening into a channel in the gate compartment and thence through a pipe sewer to the main intercepter. As the level rises above the weir crest the float rises and the gate drops, decreasing the size of orifice opening. The rise may continue until the gate has completely closed the orifice opening. Under such condition all the flow is discharged to the nearby water course. At times of flood, when backwater overtops the weir, the action is the same. As the sewage or flood level drops the action is reversed.

Twenty-three regulating devices and connecting sewers to the main intercepters are included in the intercepting sewer system on the west side of Maumee River. The concrete chambers have varied in cost from $2,500 to $4,500 each, while the mechanical devices of the revolving-gate type have cost $600 each and the flap-gate type $650 each, installed.

Devices of the revolving-gate type have been in operation for more than two years in connection with the Ten Mile Creek intercepting sewer. They are capable of adjustment for smaller flows than the maximum ultimately to be handled, are positive in their action, sensitive, practically free from sticking and clogging troubles and have given complete satisfaction at Toledo.

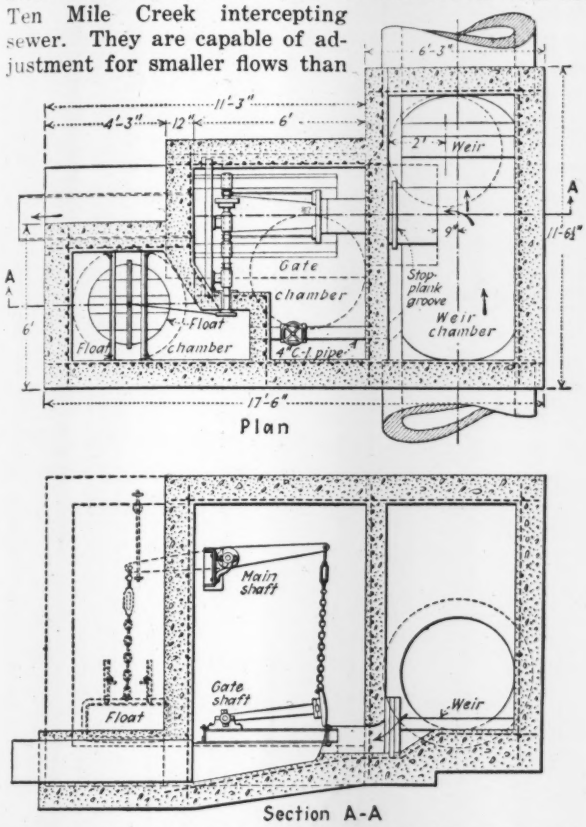


FIG. 3—REGULATOR CHAMBER HOUSES REVOLVING GATE

Inverted Siphons—Inverted siphons have been constructed at five different places where the main intercepting sewers cross water courses, two on the Ten Mile Creek intercepter at Ayres Ave. and the Overland plant, two on the West Side and Swan Creek intercepter at Junction Ave. and City Park Ave., and one on the West Side branch intercepter at Clayton Street. The siphons consist of two or three lines of cast-iron pipe, encased in concrete, together with special concrete chambers at the upstream and downstream ends of the siphon proper. The entrance and outlet of each one of the cast-iron lines are controlled by a sluice gate so that the number and size of pipes in use may be adapted to the sewage flow. At the downstream end each cast-iron pipe terminates in a flanged base tee which makes cleaning of any line possible.

Cofferdams were used during the construction of all the siphons. These cofferdams were built around the site of one of the siphon chambers on shore and extended out to the middle of the stream. On completion of one-half of the siphon the cofferdam was built out from the opposite shore overlapping the finished work and the structure completed therein.

Table I gives the length, sizes, head loss and costs of the various siphons. The accompanying sketches show the general arrangement of these structures.

Main Intercepting Sewers—The intercepting sewer system for the area west of the Maumee River comprises 16 miles of main sewer, practically all in tunnel through tight blue clay, built without timbering, at depths ranging from 25 to 50 ft. The system on the West Side consists of two main units designated as the Ten Mile Creek intercepting sewer and the West Side and Swan Creek intercepting sewer. The latter unit also includes a small lateral line designated as the West Side branch intercepting sewer. All of the intercepting sewers with

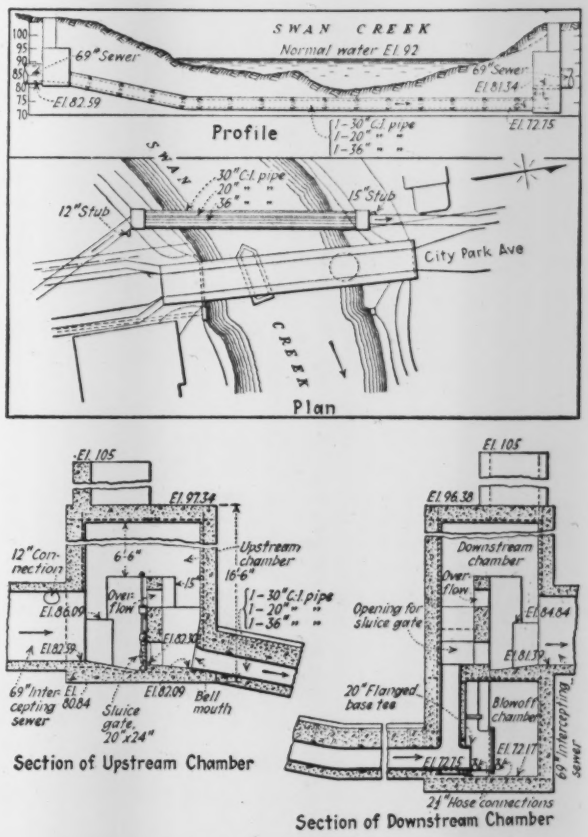


FIG. 4—CITY PARK AVE. MULTIPLE SIPHONS

a diameter greater than 24 in. are of monolithic concrete. Vitrified pipe has been used for the smaller sizes. On the tunnel work, shafts were sunk at 400- to 600-ft. intervals, usually at manhole locations, and manholes were built inside the shaft excavations.

Hand methods of excavating the tunnels were used throughout the entire length of the Ten Mile Creek unit. At the outset spades and mattocks were used but were soon discontinued because the texture of the clay was not such as to allow reasonably large pieces to be loosened in the face of the heading. Hand knives for slicing off the clay from the face of the heading were used with good results. With these methods the sections excavated and lined in each heading each day averaged 10 ft. in length.

TABLE I—DIMENSIONS, LOSS OF HEAD AND COST OF SIPHONS

	Length Ft.	Size of Pipe In.	Loss of Head Ft.	Cost
Ayers Ave.	100	20 24 30	1.00	$22,000
Overland	130	20 24 30	1.15	26,000
City Park Ave.	197	20 30 36	1.25	40,000
Junction Ave.	110	16 16	2.00	11,000
Clayton St.	180	12 14	2.85	35,000

Concrete was lowered through the shafts, pushed to the heading in hand cars and then shoveled into place back of the forms. An attempt was made to place concrete through holes bored down from the surface, but this method was discontinued because it was found that a separation of the mortar and aggregate took place.

Power knives replaced hand methods of excavating tunnels on the West Side and Swan Creek units. The power knife equipment was inexpensive and made possible an average daily progress of 15 ft. in each heading. The knife itself was circular in form and was attached to a motor-operated drum by means of a cable. Pilot or "monkey" holes, about 2 ft. wide and 4 ft. high, were driven ahead at the crown of the sewer for a distance of from 15 to 20 ft. Hand tools were used for these excavations. During the mining shift the power knife was carried into the pilot hole and by power drawn back along the axis of the sewer stripping off pieces of clay 10 to 15 ft. in length and 10 to 12 in. thick. These long strips were cut up into pieces and disposed of.

Shafts on Contract 5 (West Side and Swan Creek) were sunk about 4,000 ft. apart. Concrete was carried to the headings and excavated material hauled therefrom by means of cars drawn by storage battery engines. At points on this contract where manholes were required, excavations were begun at the barrel of the sewer and proceeded upward toward the surface. Brickwork was carried up with the excavation. When unsuitable soil conditions were encountered near the surface this method was discontinued and the structure finished by digging down from the surface to meet the finished work built up from below.

Compressed air was used in constructing some 2,500 ft. of sewer near the upper end of Contract 5, since this territory is all filled ground and a large amount of sand and water was encountered.

TABLE II—COST AND OTHER DATA FOR VARIOUS SEWER CONTRACTS

Contract No.	Length of Contract Ft.	Length Each Size Ft.	Sizes Designed In.	Sizes Constructed In.	Cost Cost per Ft.	Completion Time Months	Final Estimate
Ten Mile Creek Unit							
1	18,400	17,400	72	72	$30.00	17	$589,063
		1,400	66	72	30.00		
2	17,000	13,600	57	57	27.00	14	444,023
		3,400	54	57	27.00		
3	Four storm water regulators and connections						26,617
West Side and Swan Creek Unit							
5	23,850	18,950	87	87	27.25	20	706,593
		2,260	84	84	27.25		
		2,640	78	78			
	An additional allowance of $12.50 per foot was made for the use of air on the 78-in. section.						
6	15,935	2,295	75	75	29.50	17	498,589
		2,155	72	75	29.50		
		4,940	69	75	24.50		
		1,970	66	66	24.50		
		4,575	51	51	19.50		
7	10,310	1,395	30	30	15.00	—	*167,820
		1,295	24	24	10.60		
		8,670	18	18	9.60		
8	Nineteen storm water regulators and connections						*173,6.8
							$2,606,363

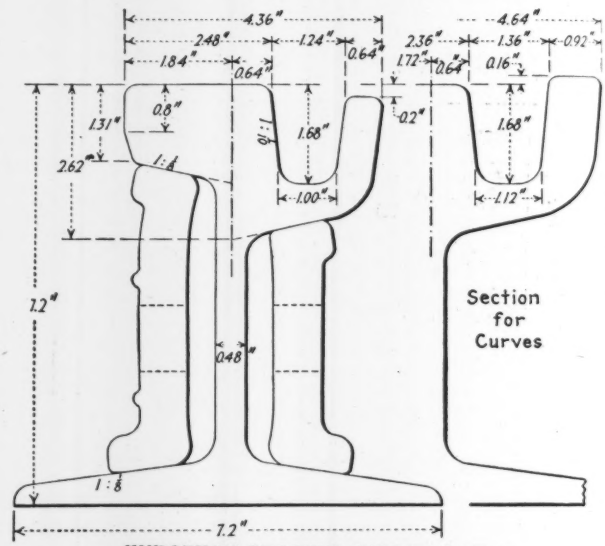
* Denotes bid price.

Table II gives information as to sewer lengths of various sizes, cost per foot, time required for completion and the total cost of the various contracts.

Graham & Henderson, of Cleveland, executed Contract 1, Harris & Tansey of Toledo, Contracts 2, 3, 6, 7 and 8; Booth & Flinn, Ltd., of New York, Contract 5. Construction of the Ten Mile Creek intercepting sewer was started under the direction of David H. Goodwillie, formerly director of Public Service, and was completed under Clarence Benedict. The original bond issue did not provide sufficient funds to complete the West Side and Swan Creek intercepter when the Ten Mile Creek intercepter was finished. Raising of additional funds to complete the West Side and Swan Creek unit was due to the efforts of William T. Jackson, director of public service, during whose term in office the latter unit has been constructed.

Standard Grooved Rails for Europe

FOUR standard sections of grooved girder rails for street railways in European cities have been adopted by the International Union of Street Railways, Light Railways and Bus Transport, having its headquarters in



EUROPEAN GROOVED GIRDER RAIL

Belgium. This action followed the recommendations of a committee on standardization of rails and track material. While the heaviest rails are 7.2 in. high, the committee notes that certain cities use rails about 8 in. high, but it is considered that the latter section is due to local conditions and that such a height is too great for a general standard. The rails are to be rolled in lengths of 50 to 65 ft. In these new standards, which are tabulated herewith, the modified sections for use on curves have a heavier guard for the outside of the groove and this guard is about ⅛ in. higher than the rail head. In the accompanying drawing is shown the section of the heaviest rail, with the modification for curves and also with the standard splice bar sections.

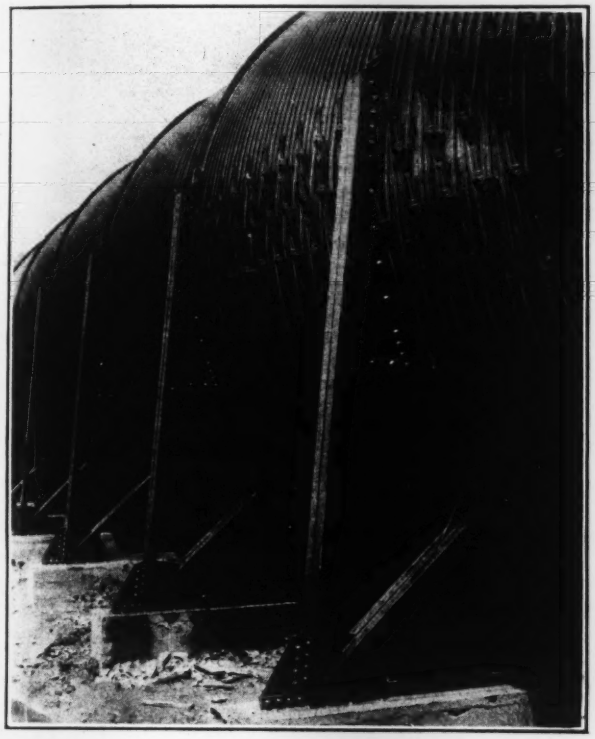
Weight per Tangent Lb.	Yard Curve Lb.	Height In.	Width of Base In.
119	123	7.2	7.2
106	112	7.2	6.4
94	101	7.0	6.2
95	102	6.4	6.4

Wood-Stave Pipe on Power Project Is 16 Ft. in Diameter

Concrete Footings Support Steel Cradles—T-Bars Pass Over Top of Pipe—Capacity of Pipe 3,000 Sec.-Ft. Under 60-Ft. Head

THE Copco hydro-electric plant No. 2 recently completed on the Klamath River in northern California by the California Oregon Power Co. required a conduit of 3,000-sec.-ft. capacity, 1,318 ft. long, to connect two concrete-lined tunnels. A creosoted wood-stave pipe 16 ft. in diameter was selected for this service, was built during the past summer and is now in operation.

The concrete footings on which the line is supported are reinforced T-beams 48 in. deep, 14 in. wide at the top, 3 ft. wide at the base, and 21½ ft. long. They were spaced 8 ft. on centers on curves and 10 ft. apart on



CLOSE VIEW OF CRADLES AND FOOTINGS

tangents. None of these footings are on solid rock. On the footings structural steel cradles, weighing 1,940 lb. each, were bolted down by six ¾-in. round bolts and grouted in place. These cradles extend on either side to a height just above the pipe center line and on the semicircular support thus provided the wood staves of the pipe were assembled in place. After the pipe proper had been assembled a steel T-bar was passed over the top of the pipe and its ends were bolted to the tops of each cradle. This T-bar, together with the cradle, took the place of the bands which would otherwise have been located at these points.

The staves are 4 in. thick and 5⅜ in. wide and are held in place by ⅞-in. steel bands with a spacing varying from 3.62 in. to 3.71 in. The maximum head on the line is 60 ft. The creosote treatment given the staves was 8 lb. of creosote per cubic foot applied according to American Wood Preservers' Association specifications. Operating conditions are such that when this pipe is in service it will always be full and under

CONSTRUCTION VIEW SHOWING CROSS-SECTION OF 16-FT. PIPE

pressure. Steel standpipes which were installed at each end of the line where the pipe enters the concrete lined tunnels are expected to prevent the occurrence of vacuum inside the pipe and to allow the escape of any entrained air.

The pipe construction was contracted to the Continental Pipe Manufacturing Co., Seattle. P. O. Crawford is chief engineer of the California Oregon Power Co.

Form Border Utilities District in Canada

The Essex Border Utilities District Commission, composed of representatives of seven cities and a part of a township in Ontario, over the boundary line from Detroit, Mich., now has control not only of water supply and sewerage, for which it was created in 1916, but also of public health, a general hospital, town planning and parks. Included in the district are Windsor, Walkerville, Ford City, Sandwich, Ojibway, Riverside, La Salle and part of the township of Sandwich West. The estimated population of the district is 75,000. The commission is composed of the mayor of each municipality, serving ex-officio, and one commissioner chosen by the electorate of each municipality, except that Windsor has three elected commissioners. The commissioners are unpaid. Except for ordinary general yearly expenses, which are apportioned among the several municipalities according to the number of their representatives, the cost of the district services are based, says the Toronto *Financial Post*, on a variety of factors, subject to revision at two-year intervals by the Ontario Railway and Municipal Board, on application by any constituent municipality. Health expenditures are apportioned according to population. Capital outlays are met by district bonds of the equal annual installment type. J. C. Keith is chief engineer and R. B. Braid is secretary of the commission.

Building Avenida Progreso in Peru from Lima to Callao

Methods, Equipment and Materials Used in Building Peruvian Highway of Reinforced Concrete for Heavy Duty

CONNECTING Lima, capital city of Peru, with Callao, its principal port, a new highway known as La Avenida Progreso has recently been built, of reinforced concrete, one of its chief purposes being to provide a road stout enough to stand up under heavy freight traffic. Previous to the building of this road, communication and shipment between the two cities were either by a steam railroad, the Central Ry., by an electric line, the English Ry., or by the old highway which paralleled the electric line, the old Callao road. A great deal of the freight between the two cities has been carried by trucks and wagons on this old highway, this method having the advantage over use of the rail lines that it did not require transshipment to effect city collection or delivery. But the old highway, a combination of earth road and macadam, was badly worn, was not graded but followed the contour of the land, and required expensive maintenance. An aqueduct was located along the road to supply water for laying the dust, as there is little rain in Peru, but the water often undermined the old surfacing. Though a toll was charged on the road, it was not adequate for the extensive repairs that would have been needed for reconditioning. Also traffic was very congested due to slowing up because of the poor condition of the road. Therefore the government decided to construct a new highway that would be adequate.

Choice lay between following the old highway or selecting an entirely new route. The latter was decided upon because: (1) Under the law, building the road would be paid partly by the government and partly by owners of contiguous property, and the electric railway, being owner of land on one side of the old route, could hardly be expected to help pay the costs of a competing highway. (2) The old highway was too narrow to carry the traffic on a part of it while the rest of it was being reconstructed. (3) The cost of grading and of reducing curves would have been high. (4) The route selected was one that was being opened up through new land development which it would serve, and there was the advantage that, having two routes, the old one could take the metal-tired traffic and the new one the traffic on cushion tires.

La Avenida Progreso starts from a street in Lima which forms part of a belt highway around that city, and extends 12.26 km. (7.6 miles) in a southwest direction, as Fig. 1 indicates, to Bellevista and thence to Callao, having at kilometer 8.6 (mile 5.2) a branch to a large park which the state is developing.

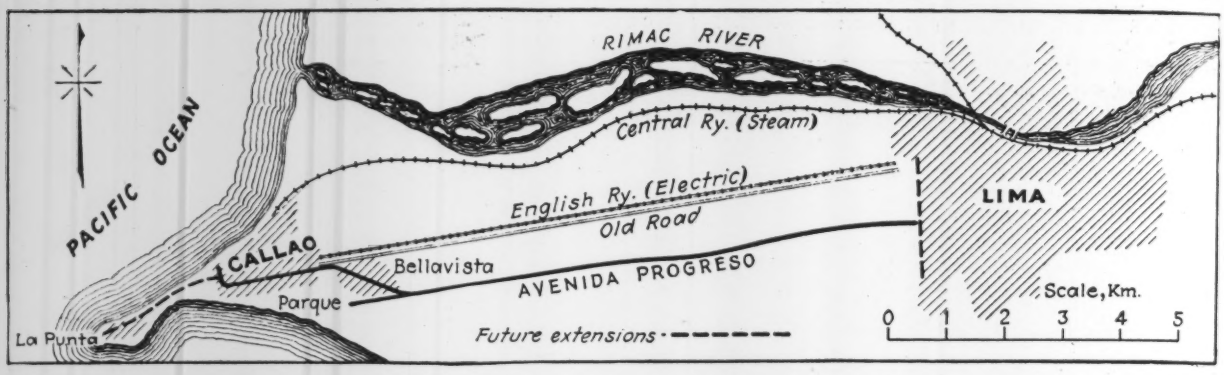


FIG. 1—ROUTE OF CALLAO-LIMA HIGHWAY IN PERU

The route included some curves; in the open country the minimum radius was 320 m. (1050 ft.), but at the entrance to Callao it was necessary to employ a curve of 65 m. (213 ft.), this being the minimum radius. On all the curves the uniform section was maintained—because of the long curves it was not considered necessary to elevate the outer edge. In general, in laying out the route consideration was given to serving the land development, but crossing of irrigation ditches was avoided where they would have had to be siphoned under the road. In making cuts and fills, great care was given to making provision for drainage.

The total width of the highway is 25 m. (about 79 ft.); the concrete strip in the center is 8 m. (31 ft.) wide; there is at each side a 1.5-m. (4.9-ft.) macadam strip, and on one side only is a 4-m. (15.5-ft.) macadam paving for the use of carts and wagons.

Stone blocks had since ancient times been used in constructing roads in Peru and were considered for this highway but decided against on account of high cost. Similarly, concrete with bitulithic wearing surface was considered and rejected on account of cost and because the highway is to be restricted to the use of pneumatic tires.

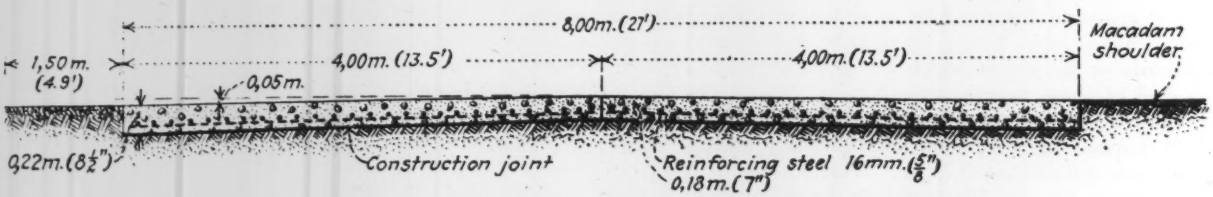


FIG. 2—SECTION OF CONCRETE PAVING ON LA AVENIDA PROGRESO

FIG. 3—BELT CONVEYOR USED FOR RAISING MATERIALS TO CRUSHERS

Reinforced concrete was the construction decided upon. The concrete is 1 : 2 : 4 mix, with a thin wearing surface of 1 : 2 mortar. The road was built in two sections, each 4 m. (13 ft.) wide, Fig. 2, without longitudinal expansion joint between them. Transverse joints were used, however, every 15 m. (49 ft.), staggered so that each joint in one half comes at the midpoint between joints in the other half.

The thickness of section at the crown is 8 in., increasing, on a crowned subgrade, to 8½ in. at the edge. Reinforcing is of mesh 6x12 in., No. 3 wire, and weighs 24 kg. per 100 sq.m. (53 lb. per 119.6 sq.yd.) ; the mat is placed 6 cm. (2½ in.) from the surface of the pavement, though some variation was permitted.

A major consideration was securing first-class aggregate. Most of the aggregate used in concrete work in and around Lima is round gravel from the River Rimac. Lima is situated in the delta of this river and therefore far from the stone quarries, there being only one quarry near at hand. Moreover, stone is quarried chiefly by hand labor and the cost of quarrying at a distance and transporting sufficient quantity for this work would have been high. So another way of securing coarse aggregate was sought.

A terrain some three miles southwest of Lima contained a top layer of sand and clay, and underneath this layer, partly combined with it, was found stone. A steam shovel excavated this material and it was carted to a point on the roadway, Fig. 3, where screens, sand washers and stone crushers were installed. The mixture of clay, sand and stone was lifted by a belt conveyor to screens which separated out the clay; the sand and stone then passed to other screens from which the sand was conveyed by gravity to the washers and the stone, also by gravity, to the crushing plant. Two crushers were used, for the reason that the sand obtained by the process just described amounted to not more than 25 per cent of the quantity of stone and was not of sufficient amount for the fine aggregate and to provide enough fine aggregate crushed stone passing 18 mm. (0.7 in.) was mixed with the sand from the washers. Aggregate not used at once was stockpiled.

Sand and stone were carried to the mixer in wheelbarrows, 9 wheelbarrows of stone being used for every 6 wheelbarrows of sand. A gang of 24 men did this work. The concrete mix, as stated, was 1 : 2 : 4. In an 8-hour day the average advance was 200 lin.m. of the 4-m. section (656 lin.ft., 13 ft. wide), or 160 cu.m. (209 cu.yd.) of concrete. The greatest day's concreting was 232 lin. m. (760 lin. ft.).

FIG. 4—CONCRETING ON CALLAO-LIMA HIGHWAY

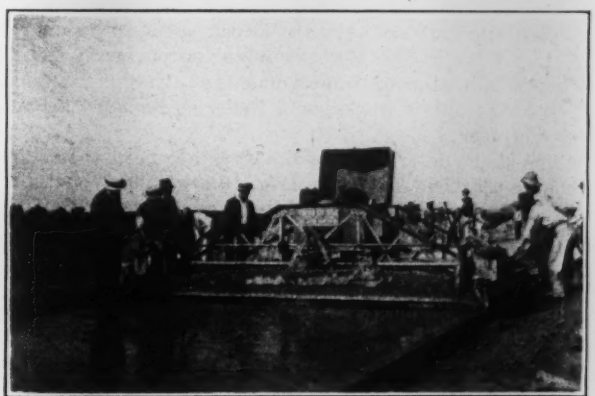


FIG. 5—FINISHING METHODS ON PERUVIAN HIGHWAY

Methods of Construction—Grading was done chiefly by hand, using wagons and carts to carry material from cuts to fills. Once the subgrade was prepared, excess material was stockpiled alongside the way or at a little distance for use if required. Two 21-E mixers on crawler traction were used, but only one mixer and one gang operated at any one time. The mixer was charged from the wheelbarrows, using boxes of 9.95 cu.m. (0.65 cu.yd.) to measure the batches. In finishing, two rollers were used, and were run over the surface, in general, three times, preceded by a belt finish. The mortar surfacing was finished by trowel, the men working on planks bridged across the concrete. A mixture of sand and cement in the form of dust was then spread uniformly over the surface and rolled. After the concrete had commenced to set well, a layer of sand or earth about an inch thick was spread over the surface, which was then thoroughly wetted. This sprinkling was done twice daily, for ten days.

The operations of mixing and placing concrete were apportioned on the basis of work done. Work was paid for at the rate of 70 cents (Peruvian) per lineal meter of finished half-section 4 m. wide. This is equivalent to 28 cents ($0.28) per lineal meter or 35 cents per cubic meter of concrete. In this way the laborers received a high scale of wage and the government received in its turn a greater quantity of work at reduced cost. This system of payment by work done was used whenever possible in the grading and ditching, as it was found that a man would do more than double the work that he would have done on an ordinary time compensation.

The first section built commenced at the point where the crushing plant was installed and extended to Lima, then served later for transporting materials for the remainder. The same methods were used in constructing the highway through to Callao, although in this case one half was finished about 1 km. ahead of the other half.

Organization—The work was carried on under the following direction: For the Foundation Co., contractor, W. C. Hebard, vice-president and general manager in Peru; W. J. Spaulding, general superintendent of construction; and Alberto Regal, engineer in charge of the work. For the Peruvian government, M. G. Masias, minister of improvements; Alfredo Mendiola, director of public works; and Federico Basadre, technical engineer.

The above description of the work has been abstracted from an article in *Ingeniería Internacional*, October, 1925, p. 471, by W. J. Spaulding and Alberto Regal.

Water Meters Run Fast When Deposit Forms

Tests on 4,000 water meters at Stockton, Calif., showed an unusual condition due to the formation of a deposit in the meters which had the effect of so decreasing the volumetric capacity that the meter reading was increased for a given quantity of flow. Fortunately, the increase was not large. Eighty per cent of the meters tested were between normal and 2 per cent fast. Only 4½ per cent were slow and these were all less than 2 per cent slow. The remaining 15 per cent were between 2 and 5 per cent fast. These figures were reported in the symposium on water-meter maintenance methods at the recent annual convention of the California section, American Water Works Association.

Colorado Stadium Is Built of Timber In Ravine

Topographic Advantage Reduces Excavation—Climate Necessitates Irrigation of the Turf—Design Details and Costs

By W. C. Huntington and W. E. Brockway
Professor of Civil Engineering, and Supervising Engineer, Respectively, University of Colorado, Boulder, Colo.

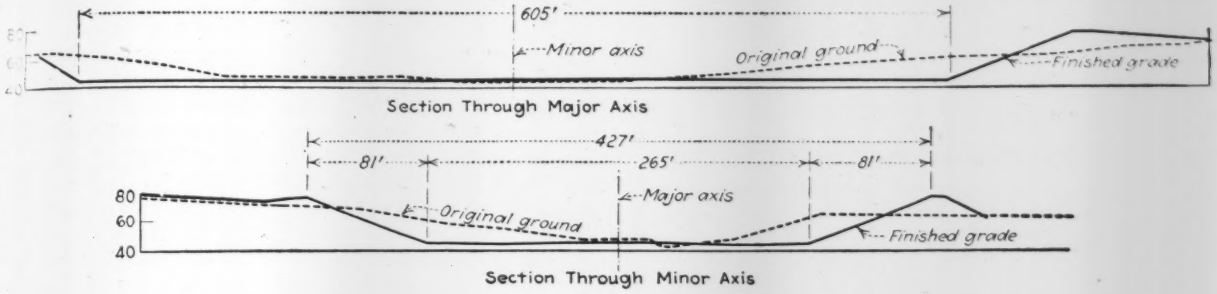
For many years the grandstands on Gamble Field at the University of Colorado in Boulder were inadequate. However, it seemed unwise to raise money sufficient to build a structure comparable in cost with other stadiums built or building throughout the country. As the alumni of the university had considered that a memorial building was a more suitable structure than a stadium, that project was well under way before a new stadium was seriously considered. The stadium project was therefore approved only on the condition that it be financed without outside assistance, money for construction to be borrowed with the gate receipts as security. It was necessary, therefore, to keep the cost down to an amount on which the gate receipts would represent a relatively large net return. This was one of the principal factors in determining the type of construction. The structure—built entirely of timber—was started in January, 1924, and completed in October of that year in time for the football season.

Type of Structure—Considerable study was given a number of stadiums in the East and Middle West before construction started. It was discovered that in general the cost of stadiums supported on earth banks is less than that of those built above ground. Since a ravine was available for the Colorado site, the structure supported on earth banks was a logical choice, the amount of excavation being greatly reduced by the ravine.

This ravine cut through the south bank of Boulder Creek which is nearly 40 ft. high. Either the U-shaped plan or the horseshoe plan with the open end to the north fitted the topography. Since an open end permits better circulation of air than the closed bowl and makes it possible to provide an open 220-yd. straightaway track, this feature influenced the design.

The horseshoe plan with curved sides was adopted primarily because of its appearance but also because each spectator is given a better view of the field and the rest of the fans. An incidental advantage in a structure entered from the top lies in the tapering aisles resulting from the curved sides, if the length of each row of each section along the sides is made constant. This constant length gives a simple system of seat numbering and can be so chosen that the seat and runway timbers will cut to advantage. The tapering aisles are desirable because their widths are proportional to the number of persons to be accommodated. Around the end of the horseshoe the curvature is too great to be taken up entirely in the aisles, so the sections are made wider at the top than at the bottom.

Drainage and Irrigation—The drainage of football fields has been the subject of considerable study, but it is more of a problem in localities with heavier rainfall than that recorded at Boulder. Though it was recognized that an efficient drainage system would hasten the drying of the field after a rain or snowstorm, there was a greater consideration which the dry climate of Boulder demanded, namely, that of irrigation to keep



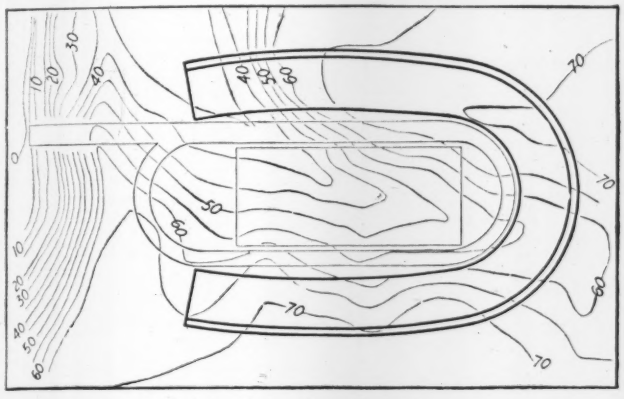


FIG. 1—TOPOGRAPHY OF STADIUM SITE IN PLAN AND ELEVATION

the field in good condition. Therefore, no drainage was installed except drains around each side of the track, the inner drain to take care of the water from the field, and the outer drain to take care of the drainage from the inner slope of the earth banks. The field was crowned 1 ft. in the center, sloping in all directions to a level grade around the edge of the track.

The ravine in which the stadium is located carried a continuous flow of water which was conducted under the field by a 15-in. tile drain. This drain has a rapid drop in grade at the south end under the seats where the playing field lies from 12 to 15 ft. below the original ravine bottom. A drop manhole was constructed at this point with a valve placed at the outlet for the 15-in. drain at the bottom of the manhole. By closing this valve the manhole can be filled with water. Another pipe line runs from the manhole under the surface along the longitudinal axis of the field. This pipe line is provided with risers and valves at 100-ft. intervals. By closing the valve of the 15-in. drain and opening that of the pipe line, the natural flow in the drain can be made to back up in the manhole and flow through the pipe line and risers to the field, thereby affording an ideal system of irrigation. A piece of sod is placed over the risers during the games.

Dimensions—The 25,000 seats are provided in 31 rows with a width of tread of 30 in. and a rise varying from 10½ in. at the bottom to 13½ in. at the top, the increase in rise being slightly less than ⅛ in. for each row. The seat height is 18 in. and the width per person 18 in. throughout. A 3-ft. runway is provided at the bottom which gives an overall width of the seat structure of 81 ft., allowing 6 in. for the width of the bottom railing. As the distance from a person's knees to his back when he is seated is about 24 in., a tread width of 24 in. is evidently too small for comfort, even though the seats are designed so that the spectator may place his feet either under his own seat or the seat in front of him. Considering the room required by a person in passing others to reach his seat, the tread width should be at least 27 in. The 30-in. tread provided in the Colorado structure has proven advantageous, but for structures of a more expensive type, and those in which capacity is a prime consideration, the tread width of 27 in. is probably more appropriate. Any further reduction is undesirable.

The overall length of the stadium, not including the outside runway, or earth banks, is 600 ft. and the width 432 ft. The top seat is 33 ft. 2 in. above the playing field. The horseshoe shape is a combination of two arcs with radii of 1,157 ft. for the sides and another arc tangent to these and forming the south end, the radius of which is 118 ft. All dimensions are measured from the face of the front railing. The corresponding radii for the back of the back row are 1,238 ft. and 199 ft., respectively. The press stand is located at the top of the structure on the west side and opposite the center of the field. Box seats are located only in front of the press stand.

The entire structure is surrounded with a woven wire fence located so that the field cannot be seen from

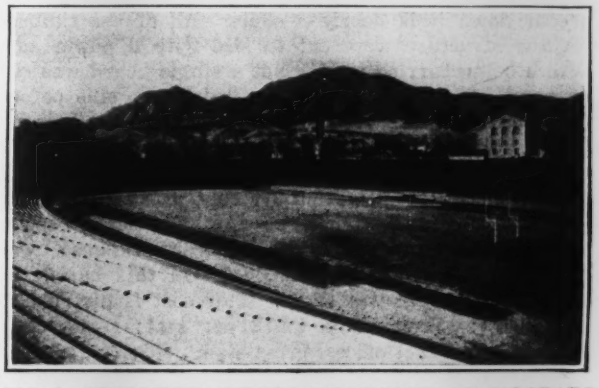


FIG. 3—COMPLETED STDIUM, UNIVERSITY OF COLORADO

the outside. Because the stadium is entirely below the ground level, the seats are easily reached from a graveled runway located around the top of the structure. The minimum width of this runway is 10 ft., but in most places it is much wider. Twenty-three radial aisles lead from this runway down through the seats to the lower runway, each aisle serving approximately 1,100 seats. These aisles have a top width of 6 ft. 3 in. and a bottom width of 3 ft. Two of them are at the extreme north ends of the sides and each of the two serves one-half of a section. The gates for general admission are located at the south or closed end, and those for students on the west side adjacent to seats

reserved for student use. Exits are provided in the fence at frequent intervals.

Construction—Timber was chosen for the structure in preference to concrete primarily on account of its lower cost. The disadvantages of timber are its relatively short life, the cost of maintenance, and the danger of fire. Its advantages are the lower first cost, and the comfort it affords. In the Boulder climate, experience has shown that a life of at least 15 years may be expected from properly selected and treated timber. The interest charges on the cost of a concrete structure would replace the timber every four or five years, so that there is real economy in the use of timber. The cost of maintenance is not enough to change materially this advantage in favor of timber. In figuring depreciation it must be kept in mind that for a structure of this type only the seats depreciate, as the excavation which represents 41 per cent of the total cost is permanent.

Danger from fire is always present in a timber structure, but this is reduced to a minimum with heavy timber placed on or close to the ground.

The timber construction supported on earth banks consists of 4x4-in. redwood sills placed radially with a maximum spacing of 6 ft. The seats are 3x12 in. Douglas fir planks are elevated about 6 in. above the runway of the next row back and are sloped backward to provide drainage. The runways consist of two 2x10-in. Douglas fir planks, the seats and runways being supported on timber brackets spiked to the tops of the sills. Redwood was adopted for the sills on account of its resistance to decay. The brackets and runways were dipped in creosote after being cut to size, and the seat planks were painted on both sides with lead and oil.

Excavation was done principally by steam shovel and the filling by bottom-dump wagons. The earth on the stadium site is a compact clay near the surface and deeper down it is nearly a shale. All of the timbers for the structure were cut to size with a power saw before being carried to it. Not a single board was cut by hand. The brackets were nailed to the sills before they were placed. The sills were held in position by 2x4-in. stakes placed at intervals along their length.

Cost—The cost of the Colorado stadium, including the drainage and irrigation systems, excavation, seats, playing field, track, fence, press stand, ticket booths, score boards, and all other items of expense, was $67,100. The capacity is 25,000. On this basis, the total cost per seat was $2.68. This cost is distributed as follows: Excavation, $1.12 per seat; seats, 61c.; score board, ticket offices, press stand, etc., 7c.; playing field, track, fence, etc., 88c. The last group includes items which are not a part of the structure itself, and are often omitted in giving costs per seat. With these omitted, the cost of the stadium was $1.80 per seat.

There are four factors which have contributed to this low cost: The favorable site, the type of construction, the opportunity to use the dressing rooms and toilets in the gymnasium, and thus save the cost of these facilities, and lack of need for architectural treatment.

A summary of the quantities and costs may be of interest. There were 73,126 cu.yd. of excavation, costing 37½c. a cubic yard, making a total cost of $27,422 for excavation. This is 41 per cent of the total cost. Lumber used was 295,000 ft.b.m. and cost $35 per M., or a total of $10,362. The labor for erecting the timber construction amounted to $15 per M. with carpenter work at $8 per day. The labor cost of dipping the lumber in creosote was $2 per M. and the creosote $2.90 per M., making a total cost for dipping of $4.90 per M. The total labor cost on the timber construction was $4,817 and the total material cost $10,487, which gives 31.4 per cent for labor and 68.6 per cent for material. The fence is 2,400 ft. long and cost $4,685 in place, or $1.95 per ft.

Observations Subsequent to Construction—The stadium has been in use for two years, so some of the questions which arose while the plans were being prepared have been answered. One of the most perplexing was the amount the earth banks would erode. The banks are of clay, containing practically no sand

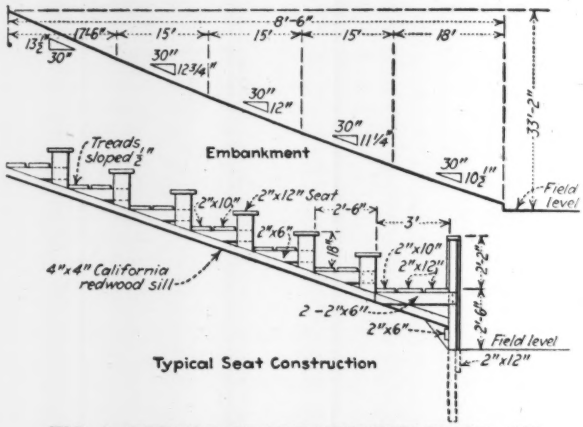


FIG. 2—DETAILS OF EMBANKMENT SLOPE AND SEAT CONSTRUCTION

or gravel. Heavy downpours of rain have caused some erosion and the dirt which washed down the inner slopes lodged against the boards forming the front parapet. The lower boards were removed and the dirt taken out. The erosion has not been serious and will be less so in the future as the fill becomes compacted. The erosion of the excavated banks where the dirt was undisturbed has been very small.

As was expected, weeds have grown on the banks under the seats and have to be cut or pulled out twice during wet seasons. Experimenting will be done next season to determine whether the planting of low-growing, trailing plants under the seats will form a mat over the banks to crowd out weeds and prevent erosion. The expense of removing weeds has not been large.

Experience has shown that there is no need for drainage under the field. The turf has stood up well even when wet. Toilet facilities of the gymnasium have proven inadequate for the use of the stadium crowds and will be supplemented in the near future.

The financing of the stadium has worked out extremely well. In addition to meeting the interest charges, nearly one-third of the principal has been paid off in two years with the attendance at games somewhat smaller than had been anticipated. All features of the design have been entirely satisfactory and the structure has met with general approval. If a new design were to be made with the experience gained from the present structure to draw upon, no changes would be made.

The stadium was designed and constructed by the construction department of the university, under the direct charge of Mr. Brockway with Mr. Huntington acting in a consulting capacity. The excavation was done under contract by Arvid Olsen, of Denver.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

SEWER INSTALLATION, COLUMBUS, GA.

Columbus, Ga.

COUNTY SEAT OF MUSCOGEE COUNTY. Situated 95 miles southwest of Atlanta, on the Chattahoochee River, at the head of navigation. Columbus is called the "Lowell of the South" because of its extensive manufacture; there are numerous refineries and foundries within the city, which manufacture general and southern materials and agricultural implements. Manufacturing is aided by the city's water power resources; the river at this point has a fall of 120 ft. in three miles, developing 67,000 hp. Columbus was laid out in 1828, and incorporated in 1829. It was an important Confederate depot of supplies during the Civil War, and was captured by Federal forces in April, 1865. Pop. 1920, 32,496.

DEVELOPMENT of an engineering conscience in Columbus, Ga., dates from the induction into office of Walter A. Richards, city manager at the time this was written, but since then appointed to the same position in the city of Daytona Beach, Florida. He was appointed late in 1922. Soon after that Dan Dull, then in private practice in Columbus, and an engineer who had not only served in numerous capacities on some of the largest engineering enterprises in the East, among them the construction of the Pennsylvania R.R. tunnels under the Hudson, but had also done consulting work before going to Columbus, was engaged as city engineer and superintendent of public works. Since the acquisition of those two graduate engineers, Mr. Richards having for a number of years been with the Hardaway Contracting Co. of Columbus, the city of Columbus has spent more money on needed engineering installations, and has done more in the way of educating the general public to the necessity of adequate engineering personnel and capital expenditures for engineering service than had been done in many more years than these two have held office. Now, from a city appreciating little the value of technical services, the city has acquired a real engineering conscience.

Prior to 1922 two city managers had held office. The first who was appointed after the commission-manager form of government had replaced the old councilmanic system in January of 1922, had been strange to the city. He did not understand the political history of the town. Although he was rated as one of the best among city managers, his tenure was marked by primary attention to efficient office and technical administration. He resigned after about five months, when it was apparent that he could not educate the administration to his particular system of control. The old political order had been loath to yield power to a new order, and the first city manager, all business, was thereby unpopular. The second city manager only remained with the city for five months and did not take any steps to improve materially the engineering organizations. He left the city's employ to accept another position. Mr. Richards was the third city manager. He went to Columbus first several years before assuming office as construction superintendent in building mill properties. Being an engineer, and knowing that what the city needed, besides patient attention to the grievances of its individuals, was many new engineering installations, he started the construction of an organization which would satisfy the two obvious needs of the community. It has been rather difficult for Mr. Richards and Mr. Dull to educate the community, but it has been done and as a result more was accomplished in the past two years than in ten times that period before their entering the city's employ.

Though the charter of 1922, which, incidentally, was made necessary when the federal government insisted that Columbus "clean up," because of the proximity of Ft. Benning, the largest infantry school in the country, specifically designated wherein the authority for control of police and fire organization should repose, little else was made specific. Engineering work was left as a matter of judgment to the five city commissioners. After being the subject of uncertain tenure and control during almost a year prior to 1923, it was finally organized so that now every engineering function save that having to do with water supply, is under the city engineer, who at the present time is the superintendent of public works. At the present time the city engineer has direct control over the following bureaus: highways, engineering, parks, sewers, building inspection, waste removal, motor transport, stores and supplies, and cemeteries. He holds his office at the pleasure of the city manager, who in turn is appointed by the five commissioners.

Columbus was first laid out in 1828 by government engineers. It lies on the east side of the Chattahoochee River, and the site upon which it is built is, with the exception of the small area included in the original layout, rolling country. The 1828 town was laid out in rectangular manner, with avenues running numerically in one direction and streets in the other. The original city was made full as to street widths, Broad St., the main thoroughfare, being 164 ft. in width, First to Sixth Avenues being 132 ft. and Seventh to Tenth Avenues 99 ft. Thus there is provided ample space for car parking and traffic, which naturally was not considered in the original layout. Annexations to the city, however, have contained streets laid out on every conceivable course and of an average traffic width of 32 ft. To quote Mr. Richards: "I have never seen a city that had such a promising start in its street layout, with such a poor development." In connection with the widths of streets in the rectangular city it may be said that wide parks have been provided between streets and property lines, which the city maintains. It has considerable mechanical equipment for the cutting of grass on these wide plots. The existence of the plots has also had something to do with the design of curbs and sidewalks, the latter being made six instead of four inches because of the possibility of

heavy motor equipment traversing the parking strips chipping or causing to fail entirely a sidewalk of less thickness.

Sewerage—A principal problem of the engineering department has been the provision of adequate sewerage facilities. When the present engineering control became effective the city was less than half sewered. After following some rather unique educational methods a bond issue for $250,000 was recently made available for the construction of sewers, though the city has, for years, had a one and one-half mill levy for sewer operation. The educational means were these. There was a section of First Avenue, in one of the mill slum districts, across which a sewer ran in an open swale. Every motorist going out of the city on this street had to cross the open sewer. Mr. Dull asked that he be allowed to fill the swale, putting in a large-section pipe as a culvert. This he was allowed to do. He installed a 104-in. diameter reinforced-concrete pipe across the street, for a length of only 156 ft. and filled the swale, covering the pipe. There was so much interest aroused when the inhabitants of the city saw what was happening that a large bond issue for extensive installations resulted. Now the city is working on a sewer program that will service all houses, though as yet only 60 per cent of the city is sewered.

With only 60 per cent of the city served with a sanitary system, the remainder has a can system of disposal. There are about 6,000 cans controlled by the scavenging department. These are collected once or twice a week, emptied into tank wagons and hauled to the river and dumped through a short outfall into the river. There is a charge of about $7 yearly for scavenging, and this charge shows a profit of several thousand dollars yearly, not including indirect overhead and depreciation of equipment.

What sewers are installed are a combination of sanitary and storm sewers. The character of the topography is such that all sewage discharges into the river by gravity, there being numerous outfalls. Though the dry-can system of sewage collection and disposal is now used formerly there were a large number of small septic tanks and these are being tied into the disposal pipes as rapidly as can be done. As the nearest town to Columbus which takes its water supply from the Chattahoochee River is 45 miles downstream, disposal into that river is taken advantage of. Pipe used is all concrete except 8- and 10-in. lines, which are terra cotta. Some of the main outfalls are being constructed of monolithic concrete and some of 104-in. precast reinforced-concrete pipe. There is only one section of the city where the systems are to be separate, and that comprises about 3,000 acres which the city is now working upon.

Maps—Another difficulty which the present officers were confronted with when they went into office was the dearth of adequate engineering data and maps. As a matter of fact prior to 1922 there was no map of the city which represented a complete survey. What maps existed were made by piecing together the original rectangular city, and surveys made of annexed subdivisions. In order to start any comprehensive system of engineering betterments, it was first necessary to have adequate maps. This was started about two years ago and now there is on file a complete set. Traverses were first run near the city's boundaries and when these

Engineering Work

had been tied in, block boundaries were traversed and all engineering information was included thereon. This included pole lines, lot frontages, building frontages, manholes, etc. All of this information was transferred to sheets covering a number of blocks, and that area was cross-hatched on a master map of the entire city. Not all of this detail block surveying has been done, but all that is needed for the existing program of improvement. Other maps which have been compiled include those showing the sewer lines, street paving, topographic conditions, industrial and railroad properties, population density with a division between the white and colored population, and the drainage areas. As a matter of fact the surveying job has been so thoroughly done that when the city commission authorized the making of a city plan map last year, John Nolen, of Boston, who made the map, practically made a blueprint of the industrial map which Mr. Dull had prepared. Two years ago Mr. Richards paid $25 each for two maps of the city, to a private engineer who had compiled them piecemeal from data gathered on the original city and succeeding subdivisions.

Paving—As there is a great deal of red clay within the city limits, some use is made of the natural material for roads. This material, with the proper admixture of sand and gravel, makes an excellent light-traffic highway. In some instances Kentucky rock asphalt has been laid directly on such a street, after it has been thoroughly drained and rolled.

There are about 20 miles of paving in the city, which has a total area of 6.5 sq.mi., almost half of which area was added on January of this year. Of these 20 miles, about five have been paved within the past two years. Most of the older paving, and a little of the new, is brick. However, most of the paving which was laid recently is concrete and rock asphalt. On outlying roads the tarvia penetration method has been used. Quite a lot of slag concrete has been used in the streets, due to the availability of the slag and the cheaper cost of construction. When rock asphalt is used it is placed either on a concrete or a macadam base. If placed on the former, the concrete base is first painted with tar to insure a good bond. Depending upon the character of traffic the rock asphalt is laid from one inch to an inch and a half thick. Sidewalks are, with the exception of driveways, 4 in. thick, with a 3½-in. base course of 1:2½:5 concrete and a ¾-in. 1:2 cement-sand surface.

Payment for sewers presents a rather unusual method. For connections the city levies on the property owner the cost of labor and materials from the laterals to the property line, plus 15 per cent for overhead. The property owner bears the total cost of the installation from the property line to the house. In addition the property owner has, until recently, paid a certain share of the cost of tearing up and replacing the paving when sewer lines were installed. For dirt roads he paid 50c. a square yard with a minimum charge of $5; for bitulithic, $5, with a minimum of $10; for brick $6 and $12; and for concrete, $2 and $5. The present code stipulates that where there is no lateral in the street, there is a flat charge of $25 made for laying it in unpaved streets, and $45 in paved streets. An

Of the Small City

attempt is being made to get the city government to pass legislation which will allow a direct assessment against the property for the sewer improvement. A questionnaire was recently sent out by the city seeking information from 165 cities as to the methods used in sewer work payments. About 92 per cent made a direct assessment against the benefited abuttor. But even with this information it has been impossible, as yet, to get legislation equally beneficial to Columbus. Such a law was considered only recently. After passing through various state legislative committees, it failed to pass, even in a greatly amended form. However, the ultimate form of assessment for sewer payments will doubtless be against benefited lots on a frontage basis with a depth of lot of 50 ft. or less, considered. Paving is paid for two-thirds by the abutting property and one-third by the city, with intersection costs borne by the city.

There are at least two functions which the city engineer possesses which seldom are found. He has complete control of the lighting of the city (though electricity is purchased) and he designates the kind of traffic control signals that shall be used on the streets. The actual control of traffic is entirely a police power. Street lighting has been carefully studied during the past year and a map has been made showing the type of lamp wherever placed. With the original survey in graphical form, the city engineer set about to make all lamps uniform. Now there is a lamp at every street intersection in the entire city and at least every 300 ft. between intersections, with special places provided with special lighting. The whole city is now uniformly incandescent, with 600-watt lamps at the main street intersections in the rectangular city, 250-watt lamps along the downtown streets between intersections and 250- and 100-watt lamps at intersections in other parts of the city, depending upon the density of population.

Garbage collection is done by the city, and disposal is made on dumps within the city limitis at the extreme southeast corner. The dump most used is in low-lying ground near the river and is kept constantly on fire. It has proven little nuisance so far. One dump has reclaimed several acres of land which the city intends eventually making a playground of. An interesting feature of garbage collection lies in the fact that during the six weeks of the watermelon season the amount of garbage is about double that of normal conditions, which is about 80 tons daily.

One of the things upon which Columbus is engaged at the present time is the general civic improvement in accordance with a plan laid out by Mr. Nolen at the commission of the city plan body. That includes the installation of numerous parks and playgrounds, street widening, building of a civic center, etc. It is estimated that the expenditure of $6,000,000 over a period of 20 years will complete the plan. The first thing which has been done is the erection of the city stadium, a concrete structure on an earth embankment, which was finished in time for a football game Nov. 7. In that same recreation development is a trotting track and playgrounds. The stadium, to seat about 13,000, cost around $50,000.

Great credit is due the city manager and the city engineer. They have been able to convince the city administration of the great need for adequate engineering installations to the extent that last year a bond issue of almost a million dollars was provided for public works. These two engineers form a combination of executive and technical excellence which has made the people of the city harken to the plea for a larger consideration for public works meeting modern conditions.

Cost of Scavenger Service, Manchester

THE cost of ash and rubbish collection and disposal at Manchester, N. H., averaged 86c. per cu.yd. in 1925, divided as follows: Collection, 70c.; disposal, 12c.; survey, 3c.; vacations, 1c. The equipment in service on the day of heaviest collections (600 yd., Feb. 9) was three "trucks" and 14 "teams," according to the 1925 report of L. B. Hoyt, surveyor of the Department of Highways. Collections were made weekly in the residential districts, twice a week in the tenement district and daily in the business section. Ashes and rubbish are dumped for filling in various parts of the city. An average of ten men were employed at the dumps. Garbage was collected by 99 licensed scavengers, who paid 50c. each for their licenses and gave bonds of $100. A "paid collector" was employed by the city to follow up complaints of non-collection. The population of Manchester was 78,384 in 1920. Its area is 33.9 sq. miles and it has nearly 200 miles of streets, including 40 miles of dirt roads.

Supplementary information has been obtained from Mr. Hoyt as follows: Equipment is charged against the collection service and credited to the equipment and materials account. The capital charges on equipment are included in this hourly rate so that the effect is the same as if the collection service hired the equipment from a contractor. The charges per hour are: 2½-ton motor truck, $2.70; 5-ton motor truck, $3.60; 5-yd. scavenger wagon, $0.87. These charges include the wages of the chauffeur, driver, and the cost of the teams of horses as well as the equipment charge. The city collector of garbage (on complaints) is paid $1,500 a year. Householders do not pay for the removal of garbage. The private collectors dispose of the garbage at private piggeries.

Traffic Congestion and Retail Business

The United States Department of Commerce, through its Bureau of Foreign and Domestic Commerce, has just issued Trade Information Bulletin No. 394 entitled "Vehicular Traffic Congestion and Retail Business." The bulletin abstracts the results of a study made by the department, under the direction of I. K. Rolph, of the retail merchant's reactions to traffic congestion. The survey was based upon more than 1,500 expressions of opinion from representative merchants having direct contact with the traffic problem in communities which differ in size throughout the country. In so far as it reflects the opinions of the merchants as to the effect of congestion on their business, it is a valuable contribution to the study of traffic. Further than that, it gives a résumé of the opinions of these merchants as to the causes and cures for traffic congestion which are obviously only worth while as individual expressions. The important fact brought out by the survey is that retail business is being seriously affected by congestion.

Commercial Mixed Concrete and Dry Batch Plant

Engineering Design and Lay-Out Carefully Studied and Saving Made by Using Bulk Cement—All-Mechanical Handling

By Julian Montgomery
Montgomery & Ward, Consulting Engineers, Wichita Falls, Texas

A PLANT for vending mixed concrete or proportioned dry batches is shown by the accompanying illustrations. It was laid out by L. E. Whitman & Co., paving contractors of Wichita Falls, Tex., who called in Julian Montgomery, of Montgomery & Ward, consulting engineers, to design the bins and advise in other engineering matters. The fact that the plant was designed by engineers is its outstanding claim for attention. It was designed to secure permanency, economy, avoidance of dust and flexibility in proportioning, and to permit a delivery of a wet batch or a dry proportioning simultaneously.

All materials are received in cars and are unloaded by a crane using a ¾-cu.yd. clamshell. The crane is on a trestle in order to build high storage piles. Fig. 1 shows the elevated unloading crane. The storage space

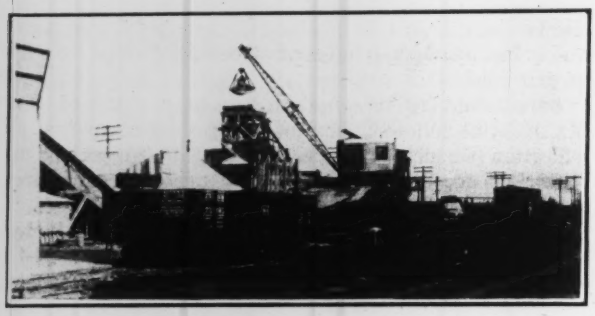


FIG. 1—DELIVERY TRUCK AND UNLOADING CRANE ON TRESTLE

Under the crane bucket appears a hopper and screen by which bank-run gravel is separated into coarse and fine aggregate. At the extreme left note the inclined housing for the belt conveyor, which is in tunnel under the stock piles and rises to the bins over the mixer, Figs. 2 and 3.

is divided into four compartments. This permits complete segregation of different kinds of aggregates. All of the bank-run gravel which is shipped in is passed through a hopper and over a vibrating screen, separating the sand and gravel. Fig. 1 shows the material piles and the clamshell unloading into the hopper and screen.

Extending underneath the four material piles is a reinforced-concrete loading tunnel. Two trap doors under each pile permit the loading of the material onto a belt conveyor. Both Fig. 1 and Fig. 2 show the housed-in belt leading up to the top of the bins. The conveyor carries the material up a 23-deg. incline and discharges it into a revolving chute which delivers to the proper bin.

The bins and structure of the mixing plant are reinforced concrete. Fig. 2 indicates the exterior appearance and Fig. 3 is a diagram of the interior arrangement. As indicated, the bulk cement bin, stone and sand bin, and the dry proportioning bin adjoin each other and have common walls. The beam and slab type of floor was built. The cement bin was designed to hold 375,000 lb. of bulk cement. The other two bins were designed to hold 80,000 lb. and 100,000 lb., respectively. In designing the walls the assumptions made were similar to those used for designing grain bins. The bulk cement is unloaded from the car and carried up to the top of the bin by a bucket conveyor. (This conveyor is attached to the front of the bin in Fig. 2.)

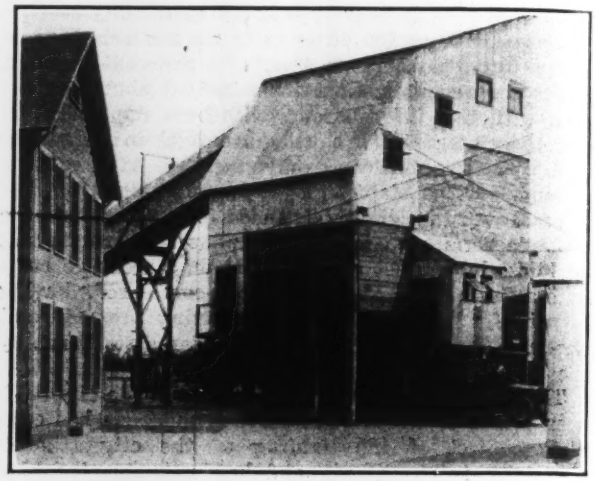


FIG. 2—SIDE VIEW OF MIXER PLANT HOUSING

Note the belt conveyor housing from the stockpile tunnel. On the front of the bin structure is the vertical bucket elevator for bulk cement.

Attached to the bottom of the cement bin is a measuring box. A spiral conveyor carries the cement from this box directly to the mixer, Fig. 3. The motor which drives the mixer is also used to drive the spiral conveyor. The mixer is placed underneath the stone and sand bin, and high enough to discharge into trucks.

The stone and sand bin (Fig. 3) is divided into three compartments. Each compartment has a measuring box underneath. The aggregates are discharged from these boxes directly into the mixer. The three bins are housed in with corrugated iron (Fig. 2), thus preventing the cement and dust from becoming a nuisance to the neighborhood.

A feature of the plant is the use of bulk cement.

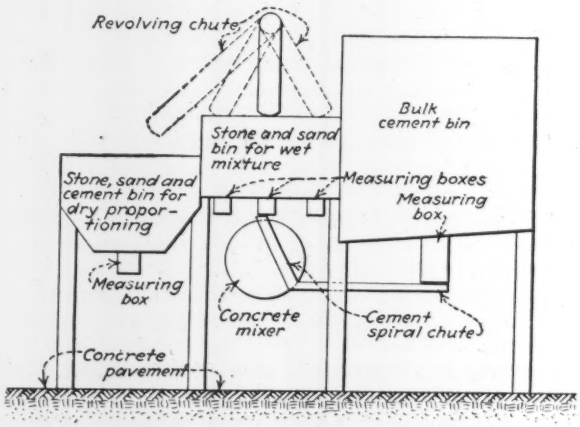


FIG. 3—DIAGRAM ARRANGEMENT OF MIXER PLANT

An average daily run is some 1,200 to 1,400 sacks. Bulk cement is cheaper by 2c. a sack than sacked cement. When the loss due to handling the sacks is considered, the contractor saves from $30 to $40 every working day by using the bulk material.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Statics in Framed Structures

REVIEWED BY GUSTAV LINDENTHAL
Consulting Engineer, New York City

DIE STATIK DES EBENEN TRAGWERKES—By Martin Grüning, Professor an der Technischen Hochschule, Hannover. Berlin. Julius Springer. Cloth; 6x9 in.; pp. 706; 434 line cuts. 45 gold marks in Germany.

Technical literature on statics in framed structures has grown to such proportions that it is almost impossible to follow all the different publications. Therefore a treatise which deals with the laws of statics in a fundamental and comprehensive manner is especially welcome. The present volume does justice to this demand; its primary purpose is to simplify the theory and show by examples its application to all kinds of engineering structures.

As a basis for the development of the theory the author chooses the principle of virtual displacements. This quite agrees with modern conceptions of statics. No other law is equal to this principle in theoretical simplicity and lucidity and in ease of practical application. As an illustration there may be cited the simple method in the book of deducing the deformation of trusses, which follows in logical development from the principle of virtual displacements. The speedy and automatic construction of influence lines for members of statically determinate structures by means of this principle is striking. The "kinematic method," which the author treats extensively, renders it possible to determine the influence lines simply by constructing centers of rotation. It is so clear and convincing that one cannot help wondering why it has not been applied more frequently.

Equally comprehensive is the principle of virtual displacements with regard to the theory of statically indeterminate structures, which is given detailed and most elaborate treatment in the present volume. The theorems of Maxwell and Betti, of Mohr and Castigliano, on which the theory is based, are shown to be special cases of this general principle. The formulation of the elastic equations becomes clear and easy. The author devotes much attention to the further simplification of the general elastic equations in enlarging the conception of the statically indeterminate quantities to groups of forces. Thereby it is made possible to formulate equations each with only one unknown quantity, which simplifies the method of computation in highly statically indeterminate systems. The author has applied this method in a number of examples, especially for symmetrical structures, and has worked out schemes of forces which can be generally applied to various degrees of statical indeterminateness. For American structural engineers the chapter on building frames (Stockwerkrahmen) should be of particular interest. In modern structural design of multistoried buildings and industrial plants this problem is of great importance. The author has undertaken a thorough investigation of this question and gives general methods for two-, three-, and four-legged frames.

Even if the first chapters of the book do not set forth anything essentially new, they have the quality, as already mentioned, of simplicity and clearness. But the last two chapters are original investigations of the author, and treat the methods of difference equations quite extensively. On the whole, the treatise shows a thoroughness and completeness which can be acquired only after many years of concentration on the subject. The technical literature has been truly enriched by this valuable book, which should be of deep interest to every structural engineer, and should be in every engineering library.

Fortier's Irrigation Revised

USE OF WATER IN IRRIGATION—By Samuel Fortier, D.Sc., M.Am.Soc.C.E., Hon.M.Am.Soc. Agricultural Engrs., Associate Chief, Division of Agricultural Engineering, U. S. Bureau of Public Roads, Consulting Professor of Irrigation Investigations and Practice, University of California. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x8 in.; pp. 420; many halftones, drawings and charts. $3.

The two revisions since the first edition of this book appeared in 1915 have raised the number of pages from 265 to 420, the latest revision adding nearly a hundred pages. The main additions in the second edition were a lengthy chapter on The Use of Water in Foreign Countries and a half dozen pages on the use of sewage for irrigation. Later foreign data have been added for a few of the countries, but no change seems to have been made to the sewage-irrigation article, even though the main examples cited are in the author's own state, and the tri-city project (Pasadena, etc.) mentioned on p. 347 of the new edition has gone forward and an activated-sludge plant has been provided. One would like to know what has happened at the other California sewage farms. The author still mentions the "city of Pullman" and its notable pioneer American sewage farm as though both were still in existence, although Pullman became a part of Chicago and the sewage farm was abandoned long ago. These points illustrate the difficulties of revising a technical book rather than any serious blemishes on this admirable work, the more essential parts of which are up-to-date. The first edition was noticed in *Engineering News*, Feb. 11, 1915, p. 264.

Commendable Study of a Live Question

COST OF GOVERNMENT IN THE UNITED STATES—Compiled and published by National Industrial Conference Board, 274 Park Ave., New York City. Cloth; 6x9 in.; pp. 138; tables and diagrams. $2.

Those persons who have the bad habit of drawing most alarming conclusions from crude totals and averages of governmental tax levies, expenditures and debts might profit from a careful reading of this notable storehouse of information on The Cost of Government in the United States. Data for federal, state and local units are included in what the Foreword calls "factual" rather than "interpretative" studies. This disclaimer as to interpretative attempts is unduly depreciatory because here and there throughout the ably written technical summary and comment there are introduced notable reflections on the economic and social bearings

of public debts, taxation and expenditures on private industries, consumption of goods and private capital. These remarks go beyond the indications of tendencies but no farther into questions of justification than to show that there are two sides to the subject and that the broader social and public side deserves consideration.

Topically, the book first has a half dozen well-considered pages on Growth of Governmental Functions, then takes up Volume of Taxation in 1924 and 1925 (chiefly 1924, because of meagerness of 1925 figures yet available) Burden of Taxation by States and Localities; Public Expenditures; Public Debts. Nine pages are filled with an excellent summary—which is prefaced by the wise suggestion that it "should be read in conjunction with the text of the entire study."

The tables are admirable examples of compilation from many scattered sources and are notable for their up-to-dateness. Crude totals and averages are converted into the more significant "1913 dollars," which for certain parts of the study are based on a wholesale price index and for others on a construction cost index, besides the more common but often omitted conversions into per capita, persons gainfully employed and per family units. Some of these conversions present quite different pictures than do the crude figures of recent increases in debt, taxation and expenditures, particularly vaunted claims for federal curtailments on the one hand and state and municipal expansions on the other.

The book deserves wide study by those concerned with federal, state and local finances, whether as legislators, administrators or studious and thoughtful citizens.

A Century of Progress

HISTORY OF THE DELAWARE AND HUDSON COMPANY, 1823-1923: A Century of Progress. New York: The Delaware & Hudson Co. Cloth; 6x8 in.; pp. 755; 210 halftones.

Any one who does not believe in evolution should not read this history of the Delaware & Hudson Co., for that is its principal message, the evolution of a canal company into an important railroad company. The story begins with the organization of the Delaware & Hudson Canal Co. in 1823, a company organized by men interested in the mining of the then little known anthracite coal in order to reach the New York market. Construction of a canal was found feasible for all of the distance between the coal mines of the company in Pennsylvania and the Hudson River except for a few miles over the ridge which separated the valley in which the mines lay from the valley of the Lackawaxen River. This obstacle was overcome by the construction of the most unique railroad ever built in this country, a railroad made up in large part of inclined planes up which cars were hauled by ropes and chains, and in a lesser part by a fairly level line on which it was planned originally to use a locomotive and upon which in August, 1829, the first locomotive ever operated in this country was run. However, the locomotive was too heavy for the track and its operation was abandoned and horses were substituted for moving the cars over this portion of the line and were continued in use for many years.

Except for this inclined railroad, the company's chief method of transporting its coal was by canal and it could hardly be classed as in any sense a railroad company in those years. However, as the company began to reach out for more coal mines and larger markets, it acquired short sections of steam railroad and began actual railroad operations in a small way. By 1871 it had acquired so much railroad property that it entered into railroad operation on a large scale and from that time forward coal mining and railroad operation became its chief function. By 1898 canal traffic had fallen off to such an extent that the company's canal from the Delaware Valley to the Hudson River, which had been its main artery of traffic at the beginning of its operations, was abandoned.

The latter half of the book is devoted to the recent history of the company, now the Delaware & Hudson Co., and while it is an interesting record of that period it lacks the glamor of the story of the earlier years and loses much of its value by the inference impressed upon the reader every few pages that in all its dealings with its employees and the government the company was always right. It is unfortunate that this effort to provide the Delaware & Hudson Co. with a halo was allowed to be written into an otherwise remarkable record.

The Coming Science

MAN AND WEATHER: By Alexander McAdie, Abbot Lawrence Rotch Professor of Meteorology, Harvard University, and Director of the Blue Hill Observatory; formerly Professor of Meteorology, U. S. Weather Bureau; Senior Aerographic Officer U.S.N.R.F. Overseas, 1918. Cambridge: Harvard University Press. Boards, cloth back; 5x8 in.; pp. 99; 18 halftones. $2.

Out of the abundance of his knowledge Prof. McAdie selected for his Lowell Institute Lectures of 1924 a variety of information on "the coming science—Aerography, the description of the atmosphere." With slight changes the lectures appeared in book form early this year. The attention of hearers and readers is gained at the outset in a series of most interesting incidents under the title, The Strategy of Weather in War, showing how many an important victory or defeat on land or water was due to weather conditions. Succeeding topics are, Weather in Peace; The Structure of the Atmosphere; Clouds, Fogs and Water Vapor; Lightning; Droughts, Floods and Forecasts. For the most part, the language is non-technical but in places it is heavily besprinkled with technical terms. These must have been somewhat baffling to an audience of non-technical hearers but matter less in a book, where one can turn back to the definitions as often as need be. The striking halftone engravings add much to the interest of an unusually appealing little book.

Well-Known Annual Resumes Publication

THE AMERICAN YEAR BOOK: A Record of Events and Progress, Year 1925—Editor, Albert Bushnell Hart, LL.D.; Associate Editor, William M. Schuyler. Edited with the Co-operation of a Supervisory Board Representing National Learned Societies. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 1158. $7.50.

After suspension for five years The American Year Book, which made a place for itself between 1910 and 1919, now appears again, but with a change in publisher. The general scheme is much the same as before but the scale has been enlarged to give "a wider survey of American affairs," to which the volume is almost wholly confined and on which a vast amount of information is well presented. There are now seven parts, 40 divisions and 360 sections. The contributors number 256, against 118 in 1919. The seven parts are: Historical, American Government, Government Functions, Economics and Business, Social Conditions and Aims, Science, and the Humanities. In addition a chronology and necrology and detailed index are included. The contributors include many well known engineers and specialists in city planning, economics,

government and health, besides others equally notable in scores of other fields. Why the American Society of Civil Engineers is not a component of the "prime mover behind the publication," stated in the Preface to be "the forty-five national societies whose representatives constitute an advisory board incorporated, etc.," is an interesting subject for speculation.

New Edition of Stein's Water Filtration

WATER PURIFICATION PLANTS AND THEIR OPERATION—By Milton F. Stein, B.S., C.E., M.Am.Soc.C.E., Sanitary Engineer. Third Edition, Revised and Enlarged. New York: John Wiley & Sons Co.; London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 316; 105 halftones and line cuts. $3; 15s. net.

The untimely death of the author on Jan. 2 deprived him of the satisfaction of seeing in its final shape the third edition of his well-known work on water filtration. The new material, which adds some 45 pp. to the size of the volume, consists mostly of additions to the appendixes, of which the following are new: The Numerical Interpretation of Bacteriological Tests; The Colloidal Theory in Water Purification; and Hydrogen-Ion Concentration in Water Purification. Other new matter appears here and there. The first edition was reviewed at some length and favorably by Robert Spurr Weston, *Engineering News*, Dec. 16, 1915, p. 1172.

PUBLICATIONS RECEIVED

A READABLE PAMPHLET on Malaria and Its Prevention Among Railroad Employees has been published by the Illinois Central System, Chicago.

FINANCING CONCRETE STADIUMS, including the cost per seat of typical cases, is outlined in a pamphlet of the Portland Cement Association, Chicago and other cities.

THE ADVERSE EFFECT of vehicular traffic congestion on retail business and existing remedies are discussed in Trade Information Bulletin No. 394 of the Bureau of Foreign and Domestic Commerce, Washington, D. C.

FEDERAL VALUATION of the Railroads to date is reviewed in a pamphlet put out by the President's Conference Committee, 429 Commercial Trust Building, Philadelphia, Pa. The pamphlet is the latest of a series issued by this committee and deals with federal valuation in the period from Aug. 1, 1925, to Dec. 31, 1925.

THE PROGRESS AND STATUS OF CITY PLANNING receives much attention in the March issue of *City Planning* (75c. a number or $3 a year, 9 Park St., Boston, Mass.). Mrs. Theodore Kimball Hubbard contributes a Survey of City and Regional Planning in 1925 and there is also a survey of legal decisions on zoning, besides much other current and general matter.

AN ILLUSTRATED ARTICLE on the Portland Cement Industry in Poland, by Jan Bergson, secretary, Polish Portland Cement Mills Association, is a feature of the March issue of *Poland*, a monthly published in English at 953 Third Ave., New York City (25c. a number; $2.50 a year). There are also articles on Polish oil, cotton, economic conditions, art, music, universities, etc.

TWO YEARS LATE comes a U. S. Bureau of Standards paper on Durability of Cement Drain Tile and Concrete in Alkali Soils. Fourth Progress Report (1923). The investigation has been carried on since 1913. It is safe to assume that the chief part of the delay in publication does not rest with the Bureau of Standards. (20c. from Superintendent of Documents, Washington, D. C.)

GRADE CROSSING ELIMINATION at Dayton, Ohio, as well as the general improvement of railroad conditions in that city, is the subject of a report made by The Technical Advisory Corporation, New York City, to the Dayton City Plan Board. Street traffic and train movement studies are presented. The report contains many interesting maps, graphs and half tones.

A REPRINT of a paper before the Engineer's Society of Western Pennsylvania on The Withdrawal of Water from Lake Michigan by the Sanitary District of Chicago, and the Consequent Lake Lowering Controversy may be had on application to the author, Morris Knowles, Westinghouse Building, Pittsburgh, Pa. Mr. Knowles was one of the board of 28 engineers that reported a year ago on the subject indicated.

BLAME FOR DELAY in publishing 1922 data on Surface Water Supply of the United States, Part III, Ohio River Basin is presumably chargeable in small part only on U. S. Geological Survey. Whoever is responsible, it is a shame to have such useful data so long unavailable, but it's a case of better late than never. The work covered was done in co-operation with the States of West Virginia, Ohio, Illinois, Kentucky, Tennessee and North Carolina. (25c. from Superintendent of Documents, Washington, D. C.)

PIPE WELDING is now an every day occurrence with frequent jobs out of the ordinary. W. W. Brush, deputy chief engineer, Department of Water Supply, New York City, described one of these unusual jobs recently before the New York section of the American Water Works Association. His paper, entitled "Welding a Cracked 48-In. Cast-Iron Pipe Under 20 Ft. of Earth" has been reprinted from the December A. W. W. A. *Journal* for distribution by the Electric Welding Company of America, Foot of Court St., Brooklyn, N. Y.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

DER BETON: Herstellung, Gefüge und Widerstandsfähigkeit gegen physikalische und chemische Einwirkungen—By Dr. Richard Grün, Direktor am Forschungsinstitut der Hüttenzementindustrie in Düsseldorf. Berlin: Julius Springer. Paper; 6 x 9 in.; pp. 186; 54 halftones and line cuts; 35 tables.

CHEMICAL ENGINEERING AND CHEMICAL CATALOGUE—A catalogue of Heavy and Fine Chemicals, Raw Materials, Machinery, Plant and Equipment Applicable to Production Industries, Standardized, Condensed and Cross Indexed—Edited by D. M. Newitt. Second Edition. London: Leonard Hill. Cloth; 8 x 9¼ in.; pp. 360; Illustrated. 15s. in England.

DISEASE PREVENTION—By Herbert H. Waite, M. D., Professor of Bacteriology and Pathology, University of Nebraska. New York: Thomas Y. Crowell Co. Cloth; 6 x 9 in.; pp. 667. $4.50.

INDUSTRIAL FUEL AND POWER—Presented before the Affiliated Technical Societies of Boston, Dec. 10 and 11, 1925. Paper; 6 x 9 in.; pp. 105.

Contains papers and general discussions on Coal, Fuel Oil, Diesel Engines, Power for textile, paper, and other industrial plants, etc., and a round-table discussion.

PIT AND QUARRY HANDBOOK FOR 1926: Useful and practical information for the Sand, Gravel, Stone, Gypsum, and the Lime Industries—H. W. Munday, Editor. Chicago: Complete Service Publishing Co. Flexible; 6x9 in.; pp. 576; illustrated $5.

As a combination handbook and equipment catalog this volume shows improvement over previous issues. There are a number of good authorities among the writers of special articles which, naturally, are general descriptions rather than compilations of working data. The volume can only be helpful to the run of pit and quarry operators to which it is addressed. It is not a book that can widely help the mechanical engineer or technically trained manager of large rock products outfits.

RAILWAY TRACK AND MAINTENANCE: A Manual of Maintenance-of-way and Structures (formerly published under the title of "Railway Track and Track Work)—By E. E. R. Tratman, A.M., Am.Soc.C.E., M. A.R.E.A., Assoc. Editor *Engineering News-Record*. Fourth Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 490; 120 line cuts and halftones, 33 tables. $5.

RELATIONS BETWEEN THE TEMPERATURES, PRESSURES, AND DENSITIES OF GASES—Circular of the Bureau of Standards, No. 279. Washington: Government Printing Office. Paper, 7x10 in.; pp. 85; 16 tables, 23 line cuts. 25c.

THE TECHNOLOGY OF THE MANUFACTURE OF GYPSUM PRODUCTS—Circular of the Bureau of Standards, No. 281. Washington: Government Printing Office. Paper, 7x10 in.; pp. 81; 40 line cuts and halftones. 30c.

ÜBER DEN EINFLUSS DES MECHANISCHEN FAHRWIDERSTANDAUSGLEICHS AUF DIE BERECHNUNG DER EISENKONSTRUKTION VON BRUCKENKRANEN—By Dr. Ing. Luz David, Magistratsbaurat bei der Baupolizei, Berlin. Berlin: Guido Hackebiel. Paper; 5x7 in.; pp. 42; 20 line cuts.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

The Wall Dismissal

Sir—As a St. Louis engineer familiar with the situation, I am writing to correct impressions that will inevitably follow your article on p. 461 and editorial on p. 431, of March 18, 1926, in reference to controversy between E. E. Wall and Mayor Miller of St. Louis.

Since the above date, after giving Mr. Wall another opportunity to resign, the mayor removed him, primarily for lack of co-operation with his associates and for personal conduct unbecoming an important city official.

The controversy was not, as your article would indicate, one between a politician and an engineer. Mayor Miller has been called the peoples' or anti-machine mayor. In the Republican primaries, he ran against candidates supported by the regular Republican organizations. His supporters had not previously taken any part in politics but desired an independent mayor who would free the city of the control of the regular organization.

Mayor Miller's nomination was distasteful to those of his own party who had been active in politics and many of them voted for the Democratic candidate. Mayor Miller won by a small margin and took office a year ago. He cannot be called a political mayor.

Although not an original supporter of Mayor Miller, I can state positively that he is earnestly striving and succeeding in giving St. Louis an honest business administration, which will measure up very well with administrations of predecessors.

Shortly after his inauguration he reappointed E. R. Kinsey as president of the Board of Public Service on account of the excellent record Mr. Kinsey had made during twelve preceding years, replaced three other directors by three men not previously active politically, and promoted Mr. Wall, who had been water commissioner, to director of public utilities.

Shortly after Mr. Wall's appointment, it became apparent that a mistake had been made. While he had presided satisfactorily over a department in which he passed from bottom to top, he soon indicated that, although he had every requisite of technical ability for supervision over the Water Department, he did not have the executive capacity necessary to preside over a great city department and cared nothing whatever for co-operation with his associates.

In past years the newspapers here constantly opposed city administrations. Time after time they created an atmosphere of Mr. Wall having openly defied political raids on his department, as a result of which his superiors have left him severely alone and he has been known as the czar of the Water Department. On the other hand, this policy has been popular and the mayor's opponents have seized on it to make political capital.

In Mr. Wall's writings and talks he has featured co-operation, but he failed to co-operate to such an extent that his four fellow members of the board, two of them brother engineers and friends of long standing, advised the mayor that he should be replaced.

Director Brooks of the Department of Streets and Sewers stated the situation very aptly when he said that through lack of co-operation the Board of Public Service was in the position Sousa's Band would be in, if, while trying to play the "Star Spangled Banner," the perfectly good cornetist should insist on playing the "Last Rose Of Summer."

The issue that brought the matter to a head was the discharge of a very forceful superintendent of construction who did not get along well with the city electrical engineer. It would be difficult to find the difference between the "practical" and the "theoretical" better exemplified than in these two men, each entirely competent in his own field of endeavor. I have known both for many years. The superintendent has done work for me very efficiently. He is an earnest, hard worker. He has the same trait that many other efficient field superintendents have of discovering and reporting back the shortcomings of the office engineers.

Mr. Wall's predecessor made this practical man and the theoretical man work together. Mr. Wall solved the problem by discharging the practical man. The mayor asked for his reinstatement. Mr. Wall's successor has reinstated him. It was Mr. Wall's refusal to comply with the mayor's request that caused the mayor to bring forward other charges as Mr. Wall insisted on charges being preferred and having a public hearing, all of which was done.

After the controversy arose the mayor offered Mr. Wall his former position as water commissioner. I believe that, even after the trial, Mr. Wall could have continued as director by a promise of co-operation with his associates on the board and with the city administration. As he did not follow that course, the mayor offered him an opportunity to resign, failing in which he was summarily removed and one of his former employees, recently appointed by Mr. Wall as water commissioner, was promoted to take Mr. Wall's place.

There was never any question of the technical man's right to the governing of technical matters under his control but only the conduct of an appointive officer in the administration of a city department in co-operation with co-ordinate officers.

St. Louis has never had and does not now have any reason to complain of "St. Louis politician's raid on the engineers in its staff of city employees." On the other hand, St. Louis engineers have been free from political disturbance, as evidenced by Mr. Wall's thirty-four years' service under different administrations, and many cases of lifetime service of engineers in St. Louis's employ. Engineers in the city employ have been treated well, paid well, promoted when opportunity offered, deferred to by the elected officials and generally respected and relied on more than in any other large city with which I am familiar.

The long continued services rendered the city by St. Louis engineers and freedom from political influences, in co-operation with other efficient city officers, explain in large part why the cost of city government in St. Louis is far below the cost in other comparable cities.

Two of Mr. Wall's associates who advised the mayor that his resignation would be desirable, his successor, and the writer are fellow members with him of the American Society of Civil Engineers, and hold him in the highest regard. I believe the others agree with me that, although the Wall incident is regrettable, the mayor had no alternative under the circumstances.

St. Louis, Mo., April 8, 1926.

C. E. SMITH, Consulting Engineer.

Is Fill Between Sleepers Necessary for Fireproofing?

Sir—It has long been the custom, and in many cities a legal requirement, that in fireproof buildings which have wood floors the space between the sleepers to which the floor is secured should be filled with incombustible material.

Formerly it was necessary to hold the sleepers themselves from warping by placing around them a sleeper fill, usually a weak concrete. This introduces a course of wet material next to the wood and is a fruitful cause of floor trouble, even if paper is laid directly under the wood, above the fill. When loose dry material (sand, plaster refuse, for instance) is used it often will work up through the floor.

There are now a number of devices for securing sleepers directly to the concrete which do not depend on or require the aid of sleeper fill. Sleeper fill is wet, costly and heavy; its use slows up completion of operations and its weight adds materially to dead-loads. The latter is especially true with some of the lighter types of construction now coming into use. It has been assumed that this sleeper fill is necessary for fireproofness. Is there any warrant for this belief?

Have any test or actual fires shown that omitting fill contributed to fire losses? With or without fill, will not even a comparatively small fire so damage the surface that the wood floor must be replaced?

Detroit, Mich., March 25, 1926.

WILLIAM H. ADAMS, Consulting Engineer.

Cost of Power from San Francisco's Hetch Hetchy Water Supply

Sir—Despite the city engineer's estimate that $21,000,000 of the expenditures by San Francisco on its Hetch Hetchy power and water-supply project should be charged to power development, the Board of Supervisors has placed a temporary estimate of only $9,000,000 on the capital invested in this power development. It is understood that this estimate is intended only for use in segregating funds during the current fiscal year and is not to be taken as the final statement of capital charges. Will such action change the facts or mislead anyone? It gives the impression that the cost of the power is to be made to appear relatively low. Is this in accord with the facts? The city authorities elected, without effective protest from any source, to expend for quite a different project, the funds with which a water-supply project under the Garfield permit was to have been constructed. Instead of the proposed progressive development of a water-supply project, as authorized by the bond election in 1910, of which the first unit could have been completed in three to five years, well within the limits of funds provided for the purpose, large-scale power and water development has been made the program.

The Hetch Hetchy dam was built, including as an accessory many miles of costly mountain railway. This dam was not a feature of the Garfield permit project. The 18-mile tunnel through the mountain from the Early intake on Tuolumne River to Priests at the forebay of the Moccasin Creek power station, to carry 400 m.g.d. of water (about 600 sec.-ft.) has been constructed, as also the Moccasin Creek power station and the transmission line to the new substation at Newark. In addition to the power plant and storage on the Tuolumne River at Hetch Hetchy, storage works have also been completed at Lake Eleanor and about $6,000,000 has been invested in a pipe line across the Santa Clara valley to be used temporarily by the Spring Valley Water Co. for the delivery of water caught in its Calaveras reservoir. The construction of these elements of the present municipal project has exhausted the funds made available by the early bond issues, leaving the foothill tunnel in the Sierra Nevada, a pipe conduit across the San Joaquin Valley and the tunnel, over 30 miles long, through the Coast Range from the San Joaquin Valley to the Santa Clara Valley, as the larger of the project features yet to be provided. Of these features the tunnel is the one which will determine the time when the delivery of mountain water can begin.

This proposed tunnel on which initial expenditures, largely in the nature of exploration, are about to be made, was not a part of the Garfield permit project. That earlier project called for a first unit, with a pipe line across the Coast Range at Altamont Pass, of a capacity of 60 m.g.d. Under this original project there could have been provided within a few years an amount of Tuolumne River water about 50 per cent greater than the present delivery of the Spring Valley Water Co. and there would have been thus assured to the city, including the present sources, an early aggregate dependable water supply of 100 m.g.d. or enough for about twice the present population of San Francisco.

But this program of progressive water development has been abandoned. Instead of having this supply delivered into nearby reservoirs and actually available within a few years after the commencement of construction, the delivery into the Bay region of Tuolumne River water, after some ten years of construction work, is still far in the future. To what is the change in policy to be ascribed if not to a misdirected attempt to bring in cheap power? What is the administration trying to do? The people of San Francisco are now expected to accept the fiction of a realization of this cheap power dream. May not the question be put as to whether cheap water is not as important as—even more so than—cheap power? Why fool ourselves? Are not the costs due to postponement of the possible realization of a water supply chargeable to the power development program? Should not the $10,000,000, more or less, already paid by the taxpayers in their annual budgets for interest during construction be taken into the account and, in the main, allotted to the investment for power? Should not the costs involved in the premature expenditure for a Hetch Hetchy dam be charged to the power account? Should not the premature investment in the expensive Sierra Nevada tunnel be taken into account in determining what power production is costing San Francisco? Should not the inconvenience, too, and the repeated menaces of water shortage be charged up to the power feature of the city's water project? If not, what will be the cost of the Tuolumne River water when the first of it makes its appearance, perhaps ten years from now?

The demand for water upon completion of the conduit will not jump at once to the capacity of the conduit units. Even if it did, the high cost of the water, all cost factors taken into account, would astound the rate payer and yet either the rate payer must bear the burden or it will fall on the taxpayer. There is no escape. A few figures will give some idea of the city's project as it looks today. The gross income from power sales is said to be about $2,000,000 per annum. Operation and depreciation are, it is believed, costing about $350,000 per annum. Interest on about $60,000,000 of present-day investment, including outstanding and redeemed water bonds, and interest already paid, and expenditures for investigation and preliminaries are about $2,700,000 per annum. The opportunity which the city has created to enjoy a revenue from the sale of power therefore appears to be costing the taxpayers at present about $1,000,000 per annum, with a prospect that this annual sacrifice, growing with each new sale of bonds, will continue some ten years longer. The further question, therefore, presents itself as to why this deficit, resulting as it does from a diversion of funds to power development and consequent delay in completion of the water project, should not be charged in large part to the cost of the power output? What, then, is the real cost of this power output now and prospective?

C. E. GRUNSKY,
Consulting Engineer.

San Francisco, Calif.,
March 1, 1926.

[This letter was submitted to M. M. O'Shaughnessy, city engineer, San Francisco, and he has replied as follows.—EDITOR.]

Sir—Doubtless the foregoing letter by Mr. Grunsky was inspired by the action of the San Francisco Board of Supervisors in establishing a figure of $9,000,000 as the investment on which interest should be charged against the cost of power production by the Moccasin power plant, instead of $21,000,000, as recommended by my office. This action of the board was taken after it had been clearly pointed out that the effect would be to make the cost of power production apparently very low and if adhered to the cost of water correspondingly high.

The Raker bill, under which the grants of right-of-way were obtained from the federal government, provides that, in determining the cost of power production for sale purposes, the charge to power shall include a fair proportion of the cost of lands, dams and conduits, and the city engineer's figure was based on a 50 per cent division of the cost of all elements used jointly for water and power.

The purpose of the advocates of this low power charge was not to make the power appear cheap, but to enable them to divert the power revenue from its legitimate application to the payment of bond interest and apply it to the construction of an extension of the transmission line from Newark to San Francisco, thereby necessitating the payment of that portion of the interest charges from taxation.

I am in full accord with Mr. Grunsky in his condemnation of this proceeding and if he had confined himself to a criticism of these low false charges, I would not have felt called upon to reply to his communication. However, he follows this with a rather extended criticism of the program of construction of the Hetch Hetchy Project on what he terms a large-scale power and water development. He points out correctly that there has been built an 18-mile tunnel through the mountains from Early intake to Priest forebay, with a capacity of 400 (actually 500) m.g.d., with a power station and transmission line, together with the necessary storage at Hetch Hetchy Valley and Lake Eleanor, and that some $6,000,000 has been invested in a conduit across the Santa Clara Valley to be used by the Spring Valley Water Co. for the delivery of water caught in its Calaveras reservoir. He points out that the construction of these features of the project has exhausted the original bond fund of $45,000,000, leaving the tunnel in the Sierra Nevada foothills, the pipe line across the San Joaquin Valley, and some 30 miles of tunnel through the Coast

Range, yet to be constructed. Certain of these features, particularly the 30-mile tunnel through the Coast Range, he points out were not contemplated in what is known as the original Garfield permit, upon the basis of which the original bond issue was voted.

Mr. Grunsky as city engineer of San Francisco, and Marsden Manson, his successor, were the authors of a plan to bring into San Francisco some 60 m.g.d. of water from the upper Tuolumne, which development was originally estimated on the then current prices of labor and materials in 1908 to cost some $45,000,000, and for the construction of which a revocable permit was granted by Secretary Garfield in 1910. Mr. Grunsky, in his letter, infers that a mistake was made in not developing the project on the lines originally advocated by himself and Mr. Manson. Mr. Grunsky's statement is not fair to those who have been responsible for the development program followed. He does not bring out the fact that immediately after the $45,000,000 of bonds were voted, the Secretary of the Interior issued an order to show cause why this so-called Garfield permit should not be revoked, and the city be required to develop some more available source of supply than the Tuolumne. He does not bring out the fact that following this order to show cause the city was required to investigate and report on some fourteen or more different sources of supply, as to their availability, and that a board of United States Army Engineers was appointed, which board, after reviewing all of these reports and making independent investigations, reported to the United States Government authorities that the Hetch Hetchy project, as now being developed, was not only the most available but the cheapest source of water supply. This present plan was adopted on the recommendation of John R. Freeman, who made an intensive study of the entire project and in his report set forth fully the advantages to be derived from the development of this water supply on a large scale as against the 60-m.g.d. development proposed by Mr. Grunsky.

Acting on the findings of this Board of Army Engineers, who endorsed Mr. Freeman's report, Congress passed the Raker bill, which made it compulsory for the city of San Francisco to develop the Hetch Hetchy Valley storage first by the construction of this dam to its present height and further required that electric power be developed in conjunction with the project, the first 10,000 hp. within three years and, after the completion of any portion of the project suitable for the development of power, then in successive increments of 10,000 hp. until 60,000 hp. had been developed within twenty years.

Economical development of power under the provisions of the Raker bill, as well as the protection of our water rights, dictated the construction of tunnels initially with capacity to carry the full amount of water required for the ultimate power development. In order to carry the investment in the tunnel and dam it was essential from an economic point of view to construct the necessary power plant and transmission facilities and to utilize at the earliest date possible the full capacity of the tunnels so constructed; therefore our program of construction in the so-called Mountain Division has been completed along these lines. The net result is that approximately $38,000,000 proceeds of the bond issue have been spent on the Mountain Division, including the power development and transmission line, of which approximately $21,000,000 is legitimately chargeable against power development, leaving $17,000,000 for the water development in the Mountain Division; and the city today is receiving a gross annual revenue of approximately $2,200,000, which after deducting expense of operation, maintenance and depreciation, leaves a net revenue of $1,825,000, which is more than sufficient to pay the bond interest on the entire bond expenditure in the Mountain Division.

Mr. Grunsky's letter, by inference, seems to find fault with the construction of the so-called Bay Crossing Division of the Hetch Hetchy conduit crossing the Santa Clara Valley from Irvington to Spring Valley reservoir, constructed at a cost of approximately $6,000,000. He does not point out that if the city had not constructed this conduit it would have been necessary for the Spring Valley Water Co. to have invested some $12,000,000 in a conduit which, under its plans, would have been constructed at a higher level and which would not have been available for San Francisco's Hetch Hetchy supply in the event of acquiring the Spring Valley Water Co. He does not point out that under the arrangements made with the Spring Valley Water Co. it has paid the city for interest during construction and will pay $250,000 annually for the use of this conduit during a 10-year period, and that the company has given San Francisco an option during this period to purchase all the water-producing properties of the company, including 63,000 acres of land, for $38,000,000, a price established some years ago by the California State Railroad Commission as the value of the property. The completion of this conduit and the additional development of the Spring Valley Co.'s storage facilities will have made available for San Francisco some 24 m.g.d. of water additional, and have averted what otherwise might have been a serious water famine, and has extended for some six years the time when Hetch Hetchy water must be delivered into San Francisco.

Surely neither the cost of construction of this conduit nor the Foothill and Coast Range tunnels, nor the San Joaquin pipe line can by any stretch of the imagination be charged against power development.

Fortunately many of the people of San Francisco have availed themselves of the opportunity of visiting the project and have seen for themselves the completed elements of the project, and they have not been misled by the direful prophecies of the calamity howlers, as is evidenced by their recently going on record, by a vote of 20 to 1, for a $10,000,000 bond issue for a continuance of the construction work, and this with a full knowledge that within a few years they will again be called upon for another bond issue of $25,000,000, and later for $38,000,000, to purchase the Spring Valley properties.

I enclose a statement of expenditures on the project as recently published, which may be contrasted with Mr. Grunsky's $60,000,000 figure; also a statement of revenue and operating expenses of the Moccasin power plant to Jan. 1, 1926.

M. M. O'SHAUGHNESSY,
City Engineer.

San Francisco, Calif.,
March 15, 1926.

[The total outlay shown in the detailed statement sent by Mr. O'Shaughnessy is $43,550,000 after deducting $1,907,000 for receipts from the Hetch Hetchy R.R., Lower Cherry power system and lumber sales (but without allowances for salvage value of equipment now on hand). This is $16,450,000 less than the $60,000,000 stated by Mr. Grunsky, but in that round sum Mr. Grunsky included an allowance for interest charges, which by now must total a large sum. The Moccasin power revenue and operating expense, by months, sent by Mr. O'Shaughnessy shows about $780,000 net for the 4½ months the plant was used in 1925, but here again no interest charges seem to be included. Further comment on this general subject appears in our editorial columns.—EDITOR.]

An Earthwork Quantity Dispute

Sir—A board of arbitration has been selected to settle a controversy existing between two contractors with reference to the amount of material moved in the construction of an earth dam in Indiana. The general contractor on this improvement was paid for the work on the basis of embankment measurement, while the subcontractor who built the earth dam was was paid on excavation measurement. The quantity of material in excavation was to be determined by cross-sectioning the borrow pits from which the earth was removed. The controversy involves the accuracy of the survey made to determine the amount of excavated material. These surveys are so incomplete that the arbitration board has concluded that it will be necessary to use the embankment quantities as a basis upon which to determine the amount of material measured in excavation.

The work in question was done between June and October. There was very little rain during this period. The sod was stripped off and wasted. The excavation was made with an elevating grader and the dam was constructed in lifts of from six to ten inches, bladed, moistened and compacted with teams hauling loads over the fill, without the use of a roller. The soil was clayey loam containing about 10 per cent of gravel. Although the dam was constructed in 1924, there has been no noticeable settlement. In order to determine the amount of excavated material, it will be necessary to ascertain the relation between earthwork quantities measured in excavation and in the corresponding fills.

It occurred to us that through you we could obtain some information with reference to this relation, which would assist us in settling this controversy.

March 15. 1926. ARBITRATORS.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Civil Engineers Board Meets in Kansas City

Large Increase in New Members and Transfers—Action Taken on Special Committees

(Engineering News-Record Staff Report)

A well-attended meeting of the Board of Direction of the American Society of Civil Engineers was held in Kansas City April 12 and 13, preceding the spring meeting of the society.

An unusually large number of applications for membership were passed to ballot and the secretary reported to the board that the number of applications for admission and transfer received so far this year is 20 per cent in excess of those received during the same period last year.

CHANGE IN MONTHLY PROCEEDINGS

The board authorized the division of the monthly proceedings into two parts, the first to include the official proceedings of the society and the other matter now published in proceedings somewhat revised, however, as to typographical form to permit easier reading. The second part to be mailed with the first, will consist of a monthy bulletin written in more informal style.

The formation of five new student chapters was authorized for the University of Dayton, University of Florida, University of Idaho, Ohio Northern University and Case School of Applied Science.

SPECIAL COMMITTEES

Announcement was made of the appointment of H. G. Balcom, Clement E. Chase, F. O. Dufour, J. H. Edwards and L. J. Towne to represent the society on a joint committee on stresses in structural steel to serve with similar representatives of the America Institute of Steel Construction. A request for a study of possible reform in the transportation system of the country was received from a number of members and referred to the committee on technical proceedure. The board authorized the president to appoint a committee to serve on the sectional committee of the American Engineering Standards committee on standard specifications for cement, and similar action was taken with respect to a committee on safety code for cranes, derricks and hoists. A request for a special committee on standard specifications for design and construction of steel buildings was referred to the committee on technical procedure.

The board endorsed a bill now in Congress to provide for an inventory of the water resources of the United States stating its opinion that the feature providing for co-operation between the national government and the several states and other agencies is essential to the proper carrying out of the development, and directing that copies of the resolution be forwarded to the chairman of the House committee on interstate and foreign commerce.

The committee on technical procedure was made a standing committee of the board to co-ordinate the technical activities of the society. A meeting of the committee was held on April 13, at which it adopted a code of technical procedure and discussed several aspects of the technical division work.

CONSTITUTIONAL AMENDMENTS

A meeting of the directors sitting as a committee was held to consider the several proposed constitutional amendments relating to the nomination of officers that were referred to it at the annual meeting.

Since that time the committee has canvassed the opinion of the membership throughout the country and at this meeting consider tentative proposal to harmonize the several amendments referred to it and to embody that opinion. The work done to date indicates a prevailing sentiment in favor of choosing nominees for director and vice-president by the direct vote of the members as at present, shortening, however, the time required for the ballotting. In the case of the president it is thought generally that the official nominee should be chosen by a nominating committee to consist of the several directors together with the two latest living past-presidents. It is proposed also that provision be made for canvassing the final ballot prior to the annual meeting instead of during the meeting as at present. The committee is preparing a form of proposed amendment to embody these plans.

Locations for the 1927 meetings were set as follows: spring meeting, Asheville, N. C., summer meeting, Denver, Colo., fall meeting, St. Louis, Mo.

Engineering Fifty Years Ago

From *Engineering News*, April, 1876

THE workingmen of Fort Wayne, Indiana, have held an indignation meeting and resolved against building water works in that city.

* * *

Fireless engines are attached to street cars on one of the lines in New Orleans. They consist of a simple boiler and cylinder placed on trucks. At the terminus sufficient steam is taken on—as an engine does water—to last for the trip. The car obtains better speed and is more easily managed than one drawn by horses.

Suburban Water Supply Plan for Chicago Proposed

Report Made on $5,400,000 Plan To Supply Suburban Areas in Sanitary District

Suburban municipalities within the Sanitary District of Chicago, by law are entitled on request to a sufficient quantity of water from Chicago for their needs. Twenty-one of the 54 communities are supplied but inadequately either in quantity according to law or as to pressure which the law does not guarantee them. Two water companies are contending before the Illinois Commerce Commission for a franchise to serve the suburban towns and Chicago in consequence is vitally interested since it may lose customers using 22 m.g.d. As this service curtails by that much the available supply for Chicago citizens and the suction of the suburban booster pumps still further reduces the existing low pressures in the Chicago mains, Chicago is decidedly interested in relief for the suburbs which means in turn relief to that extent to Chicago.

In consequence of the above situation John Ericson, city engineer, has prepared a report on the steps Chicago would have to take to give the suburban areas adequate service comparable with that proposed by the companies:

At a cost of $5,400,000 for new construction Chicago can within two years provide a sufficient unfiltered supply for a population of 450,000 outside its limits and a present meter rates. The plan contemplates the construction of a 48-in. feeder main north and south in Harlem Avenue from Wilson Avenue to 39th St., largely outside the city limits with a connection to the new Western Avenue system with a booster near the city limits. Another conection with a new pumping unit in the existing Mayfair Station without a booster is necessary to feed into the north end of the Harlem Ave. line. This improvement would be good for 8 or 10 years only in Mr. Ericson's opinion. An extension of the Chicago Ave. tunnel system feeding the central part of the Harlem Ave. line through Central Ave. and Springfield Ave. stations and a new station would provide for an additional population of 1,800,000 people.

Mr. Ericson did not go into the matter of regional planning of a Chicago Metropolitan Water District which is also being agitated.

Detroit Bridge Project Gets Time Extension

On March 22 the Senate passed the House bill extending the time for commencing and completing the Detroit River bridge at Detroit.

Commission Reports on Proposed Lake Champlain Bridge

The Champlain Bridge Commission has reported to the New York State Legislature that a bridge across Lake Champlain is urgently needed. A sum of $25,000 is requested to complete the investigation and make a final report to the 1927 Legislature, when a similar commission will report to the Vermont Legislature. Six proposed sites are described, five at the southern end of the lake and one about 80 miles to the north at Rouses Point. Estimates for high or low span bridges at these points, vary between $548,000 and $921,000.

Experts of Maritime Nations to Confer on Oil Pollution

Invitations have been extended by the Government of the United States to a conference of experts of maritime nations on the problem of oil pollution of navigable waters. It is hoped that the delegates will convene on June 8. A dozen of the leading maritime nations have been invited to send representatives. This action followed a report presented to the Secretary of State by the Inter-Departmental Committee on Oil Pollution of Navigable Waters, which includes among its seven members Dr. Arthur N. Young, economic adviser to the Department of State, chairman, and Mayor G. R. Young, Corps of Engineers, War Department. For further information on the proposed conference and the work of the committee, which has recently made an extended report, address the chairman, as above.

Connecticut Takes a Hand in Boston Water Project

The State of Connecticut, through Gov. John H. Trumbull, is now taking a hand in the protracted controversy over an additional water supply for the Boston Metropolitan District and the City of Worcester. The governor has appointed Caleb Mills Saville, manager and chief engineer of the Hartford water-works, as his personal representative to deal with the effect upon the Connecticut River below the Massachusetts-Connecticut line of diversion of water from the tributaries of the Connecticut. Mr. Saville recently appeared before the water supply committee of the Massachusetts legislature and called attention to the effect of the proposed diversions of the volume of water available for sewage dilution, for power and for process operations in Connecticut industrial plants. The original Stearns or Massachusetts State Board of Health plan of 1895 proposed the ultimate taking of not only the Ware and Swift but in time of the Westfield and Deerfield Rivers. The latest plan cuts anything beyond the Ware for the present. It is stated that the interstate problems presented resemble those that have arisen over the Delaware River affecting New York, New Jersey and Pennsylvania, and are also somewhat like the irrigation and power problems in the Western states.

Joints in Hyperion Outfall Sewer Being Calked by Divers

Joints in the 7-ft. outfall sewer that the city of Los Angeles built out 5,000 ft. into the ocean at Hyperion last year, developed leaks that it has been necessary to repair by divers working inside the pipe through man-holes. The joints are being calked with lead wool and despite interruptions due to heavy seas during the spring months, by the end of March the calking had been completed on about three-fifths of the total length of the outfall, according to a statement from the city's engineering department. The construction of the outfall was described in *Engineering News-Record*, Aug. 20, 1925, p. 292.

Although the leaks are ascribed to a combination of causes, an important factor has been the reversal of pressure in the outfall, due to the fact that with the present low sewage flow the hydraulic gradient lies between the crests and the troughs of swells. This caused alternating pressure and suction sufficient to loosen the asphaltic compound in the joints in some places. Leaks in the bottom of the pipe disturbed the sand bedding and backfilling, as a result of which some slight shifting out of line and grade occurred.

It might be thought that such leakage would distribute the screened sewage and aid in dilution. It was found, however, that due to the difference in specific gravity of sewage and ocean water, even from the smallest leaks the sewage would rise in a pencil-like column to the surface and there form a thin widespread sewage field, clearly visible and constituting an attraction to flocks of seagulls. The portion of the outfall on which the leaks had been calked was therefore clearly visible as the work progressed.

The work is being done under the supervision of John C. Shaw, city engineer; the office engineer and construction engineer for the north outfall sewer division being, respectively, W. H. Pinkham and F. A. Batty.

A $12,000,000 New Water Supply for Albany, N. Y., Proposed

A bill authorizing Albany, N. Y., to expend $12,000,000 for an additional water supply was introduced in the New York Legislature on March 29. If enacted, the mayor would appoint a board of water supply of three members, to serve five years at a salary of $5,000 each. The board would have the power to appoint engineers and to make plans, let contracts and supervise construction of works, but all salaries paid, plans, specifications and contract awards would be subject to the approval of the city board of estimate and apportionment while the provision of funds would be under the control of both the board just named and the city council, the latter apparently with no power short of preventing a start of investigations or blocking work through refusal to authorize the issuance of bonds. A report on an additional water supply was made some months ago by Nicholas S. Hill, Jr., New York City, but no reference to it is made in the bill.

Two Men Proposed for President of Civil Engineers

The names of Anson Marston, dean of engineering and director of the Engineering Experiment Station, Iowa State College, and a member of the Iowa State Highway Commission, and of John Frank Stevens, consulting engineer, former chief engineer of the Panama Canal, have been proposed to the members of the American Society of Civil Engineers as candidates for president of the society for 1927. The first ballot for "official nominees" will be canvassed on June 1.

Street Improvement Project at Duluth Approved

City commissioners of Duluth have accepted the plans of John Wilson, city engineer, for the removal of the "Point of Rock" between 8th and 14th Avenues, West, at an estimated cost of $479,000. The plan calls for the opening of Superior Street on a 4.9 per cent grade through the rock obstruction, and the opening of minor adjoining streets. The largest item of cost is the rock excavation.

The work is to be financed by an issue of bonds authorized by the State Legislature two years ago.

Advisory Council of Michigan to Meet in Lansing

When the conference of the engineering profession of Michigan met in Detroit, Feb. 5, it provided for an advisory council of all engineering societies of the state with the idea of having concerted representative action affecting the public welfare so far as engineers were concerned. It is proposed to enlist the aid of all classes of engineers, electrical, civil, mechanical and mining. Works which the president of the Michigan Engineering Society, George H. Fenkell, who has called the meeting, can be entered into to advantage, relate to education, sociability, research, engineering plans, legislation and ethics. The Advisory Council meets at Lansing May 1.

Contract Let for Two High-Head Turbines on Buck's Creek

Contracts for the power house equipment to be installed in the Buck's Creek power plant have been let by the Feather River Power Co. The hydraulic equipment will consist of two 35,000-hp. double-overhung impulse turbines, each direct connected to a 25,000-kva. generator. Two impulse wheels of 450 hp. capacity each will be furnished for driving the exciter unit. The static head on this plant will be 2,552 ft. and the effective head 2,350 ft., the highest yet developed in this country. Contracts for the hydraulic equipment have been let to the Pelton Water Wheel Co. of San Francisco.

Details of the power development, of which the Buck's Creek plant forms a part, were given in our issue of Dec. 17, 1925, p. 1009.

Canadian Government Favors St. Lawrence Development

The attitude of the Canadian Parliament toward the development of power on the St. Lawrence River at Morrisburg, was revealed on April 7, when the application of the Ontario Government and the Ontario Hydro-Electric Power Commission for permission to carry out the project was given unanimous approval. No action, however, will be taken by the federal government in the way of granting the necessary permit until it has received the report of the joint board of engineers now investigating the question of St. Lawrence developments in behalf of Canada and the United States.

Hon Charles Stewart, minister of the interior, assured the House that once the board's report was received, action would be taken by the Government on the Ontario application and there would be no holding up of the development. The Government, the minister declared, was in sympathy with the proposals for increasing the power supply on Ontario, but he was persuaded that there should be a policy in the matter acceptable to both Canada and the United States.

Would Develop Upper St. Lawrence with One Large Dam

At a hearing before the New York State Water Power Commission on April 9, a one-stage power development for the upper 42 miles of the St. Lawrence River was proposed by the Frontier Corporation. This corporation, organized by the General Electric Co., the Aluminum Co. of America, and the du Pont interests originally applied for a license to develop the upper St. Lawrence by a series of dams. The revised application suggests a development of 2,400,000 hp. with one dam, 130 ft. high and 1,900 ft. long, situated at Hawkins Point below Barnhart Island. In this way the 83 ft. of head available between the site and Lake Ontario would be used to drive 48 units of 50,000 hp. each. Half of these would be located on the Canadian side of the river. The installation which it would require 54 months to complete is estimated to cost $238,000,000, almost $100 per horse power. This does not include transmission lines.

Testifying at this hearing Colonel Hugh L. Cooper stated that the revised plan would be the more efficient way of developing the river and will not interfere in any way with plans for deep channel navigation of the St. Lawrence River.

Detroit Zoning Plan Now Before City Council

A zoning plan for Detroit has been adopted by the City Plan Commission and transmitted to the City Council for enactment as a city ordinance. A long series of hearings on the plan is expected. Four zoning districts are proposed: Residential, commercial, light industrial and heavy industrial. Restrictions on the height and bulk of buildings are proposed.

Lorain-Huron Bridge Approved for Cleveland

Approval of plans for the Lorain-Huron bridge for the city of Cleveland, County of Cuyahoga, is announced, together with the statement that the project for approval of a bond issue of $15,000,000 for the structure will be placed before the voters next fall.

Buffalo Garbage Must Be Drained

An ordinance requiring householders to drain garbage and wrap it in paper before putting it out for collection has been passed by the City Council of Buffalo, N. Y. A contract for the construction of an incinerator was let some months ago but a start on construction has been delayed by a proposed change in site.

The John Ericsson Medal

The John Ericsson Medal, established by the American Society of Swedish Engineers, noted in our issue of April 8, 1926, p. 587, has been established in honor of John Ericsson, the Swedish-American naval engineer, designer of the "Monitor" of Civil War fame, and not John Ericson, the city engineer of Chicago, as stated in the announcement last week.

City of Watts, Calif., Votes to Join Los Angeles

An area of four square miles with a population of about 21,000 is to be annexed to Los Angeles as the result of an election on April 2 in the city of Watts, Calif., when the vote showed a majority of almost 2 to 1 in favor of joining the larger city. Of the 2,513 registered voters, 1,338 voted for annexation and 595 against .

New York University to Conduct European Art School

The Department of Fine Arts, New York University, is inaugurating the coming summer a remarkable extension of university activity. It will conduct in Paris, July 12 to Aug. 21, a course in fine and decorative art to be given in English by some of the foremost professors in the French universities, who have been selected through the co-operation of the French Ministry of Fine Arts. There are regular courses of study and they are extended by a number of week-end trips to points of interest in France, which trips later come under discussion at the classroom lectures. A special arrangement has been made whereby the full expense of the tour is covered by a payment by each student of $425, this to include all expenses incidental to travel by land and sea, subsistence in Paris, and summer school tuition fee, from the time of leaving New York, July 3, until he or she returns thereto on Sept. 2. In addition, there are a number of side trips, for which extra charge is made. Credit will be given in New York University for the work done in Paris and abroad.

Two St. Louis Engineers Charged with Unethical Conduct

A petition asking that Edmund R. Kinsey, president of the Board of Public Service, and Robert B. Brooks, director of streets and sewers, be dropped from membership in the American Society of Civil Engineers because of their testimony against former director of public utilities E. E. Wall, who was ousted by Mayor Victor J. Miller recently, is being circulated among the engineers in St. Louis.

The charges against the two engineers are that they were guilty of unethical conduct, prejudicial to a fellow member in advising Mayor Miller to remove Mr. Wall under certain conditions.

Circulators of the petition, stated that about 25 engineers have signed the petition. There are about 100 members of the American Society in St. Louis.

"There has been no effort by any of the engineers who signed the charges to learn the real facts in the case," Mr. Kinsey said in discussing the petition. "Mr. Brooks and I wrote to the president of the St. Louis section of the society asking that we be permitted to explain our position at a meeting of the organization. The president replied that he could see no reason for calling a meeting for that purpose. Beyond that I do not care to say anything about the charges. We will meet the case when it comes up."

Seek Memorial Professorship at Cornell University

A campaign is under way to raise a fund of $200,000 to establish at Cornell University the Sweet Memorial Professorship in honor of Prof. John E. Sweet, who was in the mechanical engineering faculty of Cornell from 1873 to 1879 and who was up until his death in 1916 one of the foremost mechanical engineers in the United States. Professor Sweet was not only a pioneer professor of engineering, but was responsible for the organization of American Society of Mechanical Engineers and the inventor of the straight line engine. That engine was first used at the 1876 Centennial in Philadelphia to drive the first dynamo ever made in the United States, and it is hoped to reach the culmination of the present campaign at the Sesquicentennial celebration at Philadelphia next fall. Already about $100,000 of the $200,000 has been raised.

Large Hydro-Electric Plant to Replace Paper Mill

Following the sale of the Fall Mountain plant of the International Paper Co., at Bellows Falls, Vt., to the New England Power Co., it is reported that the greater part of the buildings now used for the manufacture of paper are to be razed and that the power company will build a hydro-electric power plant on the site to generate about 45,000 hp.

It is expected that work on the project will start in the early summer.

WASHINGTON NOTES

SELECTION of settlers for experience and capital qualifications will be practiced for the first time in the history of reclamation in the opening to settlement of 20 irrigable farm units on the Riverton project, Wyo., in the present month. Prospective settlers must satisfy an examining board that they possess proper qualifications to make their success probable. The settler must have a net capital of at least $2,000 (not necessarily in money), and must secure at least a rating of "fair" in industry, character, and farm experience, in addition to having health and vigor sufficient for active farm work. There is no present provision for financial aid in farm development and for agricultural advice to settlers on this project. Legislation to provide these is pending in Congress, however.

THE policy of allowing local interests to advance money on authorized government projects to be repaid after the appropriation is available, is being extended. Its application heretofore has been confined largely to river and harbor projects but now it is proposed to amend the public buildings bill in the Senate and allow local interests to advance money to the Treasury Department to acquire sites and proceed with construction.

Such a provision in the bill authorizing the intracoastal canal project in Louisiana and Texas has advanced by a year the work on that project. Local interests are turning over to the Chief of Engineers the money necessary for location surveys. This has made it possible to secure the rights of way and to have everything in readiness for the dredges when the money is made available.

THE Alabama Public Service Commission has taken exception to the bills introduced in Congress proposing to place Muscle Shoals under the control of the Federal Power Commission. In a letter addressed to the Alabama senators the Commission says in part:

"The hydro-electric dam which it is proposed that the government shall operate is located wholly within the state of Alabama. The United States as sovereign exercises the right to control and protect the navigation of the Tennessee River at this point, but as an operator of a hydro-electric dam the United States must abide by the laws of the state of Alabama, exactly as the Alabama Power Co. or any other private operator distributing power in Alabama.

"When a government corporation engages in the public utility business in our state, its rates and service automatically come under the jurisdiction of the Alabama public service commission. There cannot exist two power sovereigns within the same state.

"Where power is to cross a state line this commission will recognize the right of the utility commission in the adjoining state to an equal but not superior claim to jurisdiction in the rates and service affecting the power in question. As long as our commission can agree with commissions of adjoining states as to rates and service in power transmitted across our state lines, there can be no ground for interference by any federal agency, either the federal power commission or any other federal authority.

"We beg to advise that the Alabama public service commission will in behalf of the state and its people resist and oppose all efforts of the federal government to usurp or exercise powers reserved by the state and not authorized by the federal constitution, where such action relates to matters under the jurisdiction of this commission."

RIGHTS to bridge the Mississippi at Natchez and Vicksburg have been granted by Congress. The original bill proposed to grant the rights to Harry E. Bovay. The proposal to confer rights on an individual met with objection on the Louisiana side of the river, where there was a demand for the construction of the bridges by a local company. A compromise was reached whereby the bridge will be built by local companies. Control is vested in a Board of Directors of seven members. Two of the directors are to be from Louisiana, two from Mississippi and three are to be named by Mr. Bovay. In this way control will be in the hands of those interested in seeing that the bridge is made toll free as soon as possible. At the same time there would be no interference with the arrangements which Mr. Bovay says have been made for financing the two structures.

Borings will begin at once and if no difficulties arise in finding foundations for piers construction will begin on the Natchez bridge before the end of the year, Mr. Bovay promises.

Chicago Wants the 1927 Water Works Convention

Forty water-works officials and those closely allied met Apr. 9 in Chicago to lay plans to get the 1927 convention of the American Water Works Association in Chicago. A. E. Gorman, sanitary engineer, Water Department, is chairman of a committee named to handle the matter. Although repeated invitations have been extended, Chicago has not had the convention in 24 years. City officials from Mayor Dever to the dozen new members in the Water Department, including John Ericson, city engineer, and H. E. Keeler, leader in Chicago of the manufacturers and their agents were all a unit in stressing the need of the convention in Chicago to help sell the city on filtration. For the manufacturers it was estimated that Chicago will pull a record breaking attendance. The Illinois, Iowa and Indiana sections have joined Chicago in the request. A choice is recommended by committees of both the A.W.W.A. and the Water Works Manufacturers Association to the executive committee which will decide the matter at the Buffalo meeting.

RANDOM LINES

Overloading?

"A ten-ton truck containing 200,000 pounds of raw rubber is a mere casual pick-up for New York bandits," says a New York newspaper. It's wonderful what the mechanical genius of man can accomplish.

* * *

Why Contractors Get Mad

From a set of specifications recently issued:

"If there is anything shown on plans and not described in these specifications it is to be done as though shown and described."

* * *

Better Get Subway Guards to Pack Them In!

"Development of a Tudor city in the Prospect Hill section, inclosed by Fortieth and Forty-fourth Streets between Second and First Avenues, overlooking the East River, at a cost of $32,500,000 to $100,000,000 and housing 800,000 people was announced today by Fred F. French, real estate operator.

Five acres of the ground in that section, comprising 200,000 square feet, have already been purchased, and it is expected that these parcels will be augmented by the purchase of from two to five more acres."—*New York Evening Post.*

* * *

Cheap Labor

Sir—This engineer's office has a new argument for better salaries among the profession.

A farmer came into the office recently, saying that the drain pipes to a private septic tank on his farm had become clogged with tree roots to such an extent that sewage was backing up in his cellar. He therefore asked that one of our sanitary engineers be commissioned forthwith to alleviate the evil, and incidentally to clean out the said s. t.

When we suggested, very frigidly, that he secure the services of a plumber he objected with, "No, a plumber would cost too much!" C. E. D.

* * *

Precise Surveying

From the *Pittsburgh Chronicle Telegraph:*

Spokane, Wash., March 13.—A piece of property thinner than paper has been discovered at Elk, Washington, near here, as a result of foreclosure proceedings started there.

Deputy Prosecutor E. J. Farley was instructed to foreclose on a city lot in Elk, except for a narrow strip on one side of the lot. Farley said it would take 8,192 pieces of such property to make an inch. He will investigate the history of the strip.

It would be enlightening to the engineering profession to know the nature of the instruments and the methods of measurements which were used to obtain such precise results. L. P. B.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Spring Meeting, Kansas City, Mo., April 14-16; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, Ann Arbor, Mich.; Annual Meeting, New York City, April 30, 1926.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City N. J., May 10-13, 1926.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington D. C.; Annual Meeting, Buffalo N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 13-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

INTERNATIONAL CITY MANAGER'S ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The Oil and Gas Power National Conference announces a national program of simultaneous state meetings to be held in some of the larger cities in the various states on the dates, in general, of April 19 to 24, although some meetings have already been held; information about dates, locations and programs of meetings may be secured from the Steering Committee, D. H. Killefer, chairman, 29 West 39th St., New York City.

The American Welding Society will hold its annual meeting in the Engineering Societies Building, New York City, April 21 to 24; the first day's meeting will be given to reports of the gas welding and the electric arc welding committees, the second day's meeting to the business meeting and technical session, and on the third day there will be an inspection trip to the plant of the Metal and Thermit Corporation.

Personal Notes

FRANK H. MAUTZ, city engineer of Marietta, Ohio, has resigned to become associated with E. Mast & Sons Co., of Zanesville, Ohio, contractor.

P. E. COOPER, topographical engineer with the Singer Manufacturing Co., Canada, has been appointed to the engineering staff of the Canadian International Paper Co., on construction of the power houses on the Gatineau River, near Ottawa.

ROGER M. EVANS has been appointed city manager of Painsville, Ohio, following the resignation of Thomas B. Wynman. During the last four years Mr. Evans was city engineer of Clairton, Pa.

L. V. BEAN, chief engineer of the Georgia, Florida & Alabama Ry., has resigned and has opened an office in Bainbridge, Ga., for consulting practice in civil engineering, surveying, drainage, valuations, paving and subdivision work.

A. H. C. SHAW, for the past four years engineer for the city planning commission at Columbus, Ohio, has returned to the city plan commission of Cleveland, Ohio, as its zoning engineer; he had previously served four years in that capacity.

R. M. SIMRALL has been appointed district engineer of the Kansas City office of the Portland Cement Association, for which he was formerly field engineer in Kansas; prior to going with the association he was engaged in various engineering work in Oklahoma and Missouri.

E. J. MEHREN, vice-president of the McGraw-Hill Publishing Co., New York City, delivered the annual Tau Beta Pi lecture at Carnegie Institute of Technology, Pittsburgh, Pa., on the subject, "The Relation of Engineering to Human Progress"; the members of the Engineers Society of Western Pennsylvania were invited to the meeting.

H. D. AMSLEY, district hydrographer in the office of M. C. Hinderlider, state engineer for Colorado, resigned March 2 to accept the general managership and superintendency of the Fort Lyon Canal Company in the Arkansas Valley near Las Animas, Colo. Mr. Amsley previous to joining the state engineer's office was engaged in government land surveys in Wyoming and railroad surveys in the San Luis Valley of Colorado.

JOHN C. PRITCHARD, whose appointment to the position of director of public utilities, St. Louis, Mo., was noted in the issue of April 8, is a native of St. Louis and a graduate of Washington University. In 1905 he became an assistant engineer in the Sewer Department of St. Louis and has been connected with that department and the Water Department for the greater part of the time since then. When the present city administration came into office, he was appointed water commissioner.

HENRY A. STRINGFELLOW, chief engineer, Acueducto Municipal de Barranquilla, Barranquilla, Colombia, S. A., for the last two years and formerly a member of the consulting firm of Kiersted & Stringfellow, Kansas City, has accepted a position with the Biggs Boiler Works Co. as manager of the pipe division. From 1914 to 1916 Mr. Stringfellow was head of the department of civil engineering of Rochester Mechanics Institute. For a year following, he was designing engineer for the Epping-Carpenter Pump Co. From 1918 to 1920 he was principal assistant engineer for the late R. Winthrop Pratt, consulting engineer, on plans for Detroit filters and pumps. Just previous to his Colombia engagement, he went to China and Japan on development work and consulting service.

HARLAND BARTHOLOMEW, St. Louis, Mo., announces the formation of an association with EARL O. MILLS and L. D. TILTON, under the name, Harland Bartholomew & Associates, with offices at 317 N. Eleventh St., St. Louis. The association will continue in the practice of city planning and allied work.

NORMAN G. YOUNG has been appointed borough manager and borough engineer of Hollidaysburg, Pa.; Mr. Young will still perform his duties as borough engineer of Roaring Spring and Williamsburg, which offices he already holds. He succeeds D. A. McCloskey as borough manager at Hollidaysburg.

Obituary

SIR BRADFORD LESLIE, London, England, well-known engineer and a builder of bridges in Bengal, died March 21 in London at the age of 94 years.

JAMES MACFARLANE, consulting engineer, Denver, Colo., died there March 30, aged 71 years. Mr. MacFarlane was a native of Perth, Scotland, and was educated at the University of Edinburgh. About fifty years ago he was a member of the engineering staff of the Canadian Pacific R.R.; later with the Union Pacific R.R. he supervised the building of the Oregon Short Line. He then was on the construction of the Milwaukee railroad through the copper district of Montana and for a long time was chief engineer of the Anaconda Copper Co.

LAMAR COBB, Phoenix, Ariz., the first state engineer of Arizona, and at the time of his death connected with the Portland Cement Association, died in Phoenix March 26 at the age of 55 years. Mr. Cobb was a graduate of the University of Georgia. He worked first with the Baldwin Locomotive Works, then in the sub-surface department of the office of public roads at Washington, in the United States surveyor's office at Denver, Colo., and at New Orleans on work of the Mississippi River Commission, then moved to Arizona, where the first state governor in 1910 made him state engineer.

G. N. MILLER, consulting hydraulic engineer, Seattle, Wash., member of the firm of Miller Engineering Co., died in that city March 26 at the age of 68 years. Mr. Miller was a native of Sweden and came to America when 19 years old. He engaged in municipal and railroad engineering in St. Paul, Minn., for years, and was city engineer of Helena, Mont., in 1889. From 1892 to 1894, he was city engineer of Bellingham, Wash., and in 1896 became designing engineer for the Cedar River water supply project for the city of Seattle. From 1902 to 1904 he was hydraulic engineer for the White River Power Co., and in 1904 entered private practice. In 1922, he organized the Miller Engineering Co.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Use of Treated Timber Increases on Railway Construction

Chief Engineers of Thirteen Lines Supply Data On Present Trends

Treated timber is now being used in larger volume and for a wider range of applications in the field of railway civil engineering than ever before. That is the conclusion presented by evidence supplied to *Engineering News-Record* by the chief engineers of thirteen representative railways in the United States who were asked for a brief statement of the experience in their own organizations.

The engineering executives who supplied this information on the use of treated timber are: C. A. Morse, chief engineer, Chicago, Rock Island & Pacific Ry.; G. J. Ray, chief engineer, Delaware, Lackawanna & Western R.R.; H. A. Lane, chief engineer, Baltimore & Ohio R.R., F. G. Jonah, chief engineer, St. Louis-San Francisco; A. E. Owen, chief engineer, Central R.R. of New Jersey; W. J. Towne, chief engineer, Chicago & North Western Ry.; C. S. Kirkpatrick, chief engineer, Gulf Coast Lines; J. R. W. Davis, chief engineer, Great Northern Ry.; W. H. Courtenay, chief engineer, Louisville & Nashville R.R.; J. E. Willoughby, chief engineer, Atlantic Coast Line R.R.; H. C. Shankland, chief const. engr., Boston & Maine R.R.; G. W. Harris, asst. chief engr., Atchison, Topeka & Santa Fe Ry.; W. G. Brown, engr. maint. of way, Florida East Coast Ry.

The accompanying table shows the outstanding uses of treated material reported by these engineers arranged to show ranking in relative consumption.

It is significant that of the thirteen replies, eleven forecast an increased use of treated timber and two state that policies adopted in 1908 and 1910, respectively, assure an extensive continuing use. One engineer reports that the increase in use during the past five years has been 60 per cent while another places the increase at from 40 to 60 per cent. From still another road comes the comment: "Each year we find that we are adding to our creosote list additional items for treatment." But another chief engineer voices the opinion of the majority in saying: "The tendency has not been in finding new uses for treated timber, but rather the lessening of the use of untreated timber in bridges, trestles, etc."

Two comments are of particular interest: One engineer expresses the opinion that in remote structures subject to little wear, treated timber is more economical than it is in heavily loaded structures in which replacements must be made because of mechanical depreciation; another engineer highly recommends treated sills and underflooring for freight houses, with non-treated maple on top. He supports his recommendations by stating that the untreated material draws enough treatment from the underflooring it rests on to preserve it, but not enough to cause any damage in the freight house.

USES OF TREATED TIMBER AS REPORTED BY THIRTEEN RAILWAYS

Figures (1, 2, 3, etc.) indicate relative importance as to consumption; they give the order of listing in response to the question: "What uses account for largest consumption."

Uses	Railways A	B	C	D	E	F	G	H	I	J	K	L	M
Track cross ties	3	1	1	1	1	1	1	2	1	..	..	1	1
Bridge and trestle timber	1	2	3	2	2	3	2	1	3	1	1	2	2
Piling	2	3	2	..	..	4	..	..	2	2	..	..	2
Dock and wharf timber	..	4	..	..	..	2	3	..	4	..	2	..	3
Foundations for buildings	..	..	..	..	4	..	..	..	..	..	3	..	4
Posts and poles	..	6	5	..	..	..	..	..	..	..	5	..	..
Ballasted deck trestle decking	4	..	4	..	..	..	..	..	..	..	..	..	..
Car decking (construction)	..	..	..	..	..	5	..	..	..	..	4	..	..
Stock pen material	..	..	6	..	..	..	..	..	..	..	..	4	..
Sheet piling	5	..	..	..	..	..	..	..	..	..	..	..	..
Bulk heads	..	..	7	..	..	..	..	..	..	..	..	..	..
Ore docks	..	..	..	4	..	..	..	..	..	..	..	..	..
Highway crossing planks	..	..	..	..	..	..	..	..	..	..	6	..	..
Block paving	..	5	..	..	..	..	..	..	..	..	..	..	..
Signal trunking	6	..	..	..	..	..	..	..	..	..	..	..	..
Cotton platforms	..	..	..	..	3	..	..	..	..	..	..	..	..
Drain boxes	..	..	..	..	..	..	..	..	..	..	..	3	..

Concrete Road Yardage

For March the square yardages included in concrete pavement contract awards, according to the Portland Cement Association were: 4,662,885 for roads; 3,050,630 for streets; and 224,879 for alleys; or a total for the month of 7,938,394 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,161,415	1,410,201	57,218	3,628,834
Feb....	2,726,611	2,010,941	274,836	5,012,388
Mar....	4,662,885	3,050,630	224,879	7,938,394
Total..	9,550,911	6,471,772	556,933	16,579,616

Business Notes

ACME BRICK CO., Fort Worth, Tex., has recently purchased the Arkansas Brick & Tile Co., Little Rock, Ark., one of the largest brick manufacturing concerns in the state. This purchase gives the Acme Brick Co., 11 plants, 6 in Arkansas, 3 in Oklahoma, and 2 in Texas.

BLAINE S. SMITH, who since 1915 has been general sales manager of the Universal Portland Cement Co., has been elected vice-president of that company. His offices will continue to be in Chicago. Mr. Smith has been connected with the Universal company since 1908 with the exception of the war period when he was in a responsible executive position in the United States Fleet Corporation. He is now president of the Portland Cement Association.

SOUTHERN IRON & EQUIPMENT CO., Atlanta, Ga., announces changes in its personnel: H. M. Pratt, formerly general sales manager, has been elected second vice-president, and R. A. Garner succeeds A. J. Merrill, deceased, as secretary and treasurer. Both men have been connected with the organization for many years.

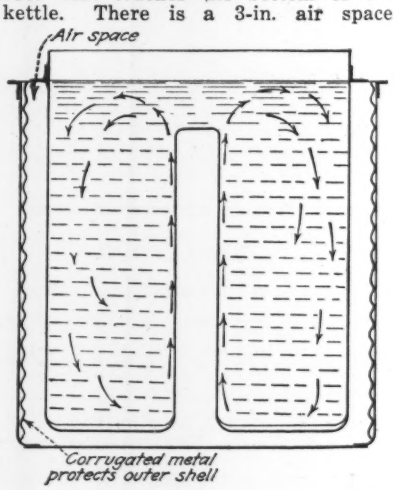
SULLIVAN MACHINERY CO., Chicago, announces the appointment of the Borchert Ingersoll Co., St. Paul, Minn., as its equipment distributor for the state of Minnesota.

GREAT LAKES PORTLAND CEMENT CORP., Buffalo, N. Y., has recently purchased all the large equipment for its new cement plant that is being constructed at Buffalo. It has also purchased a 42-inch gyratory Allis-Chalmers crusher to be installed at Rogers City, Mich. It is stated that the crushing capacity of over 2,000,000 tons per year will enable the company to go into the stone market.

Equipment and Materials

Asphalt Kettle Construction Affords Rapid Heating

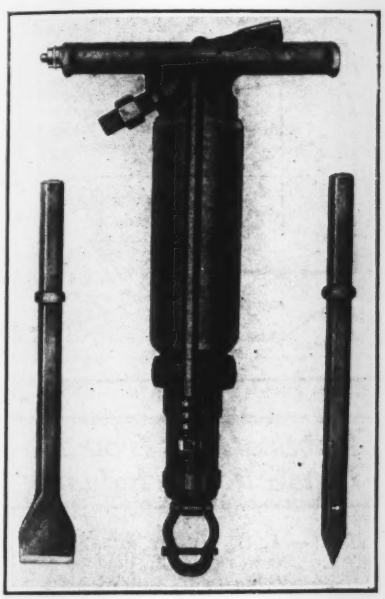
The new oil-burning jacketed asphalt heating kettle manufactured by the Renton Supply Co., Boston, Mass., is so constructed that it presents eight heating surfaces to the asphalt. No direct heat touches the bottom of the kettle. There is a 3-in. air space



around the kettle and the vaporized flame is directed through the center and circulates around the eight surfaces. It is claimed that this construction gives perfect radiation of the jacketed heat and assures the operator asphalt at a workable temperature in a very short time. No agitating equipment is used since the material is claimed to circulate in such a way as to guarantee uniform heating. These heaters are made in three sizes, 150, 300, and 500 gal. capacity respectively.

New Concrete Breaker

The concrete breaker illustrated below is a new product of the Denver Rock Drill Mfg. Co., Denver, Colo. The machine has been designed to meet the needs for a compressed-air operated demolition tool for use on jobs where

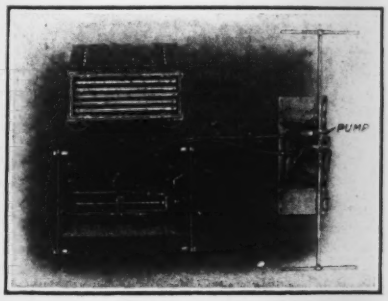


drilling and blasting are impractical. The machine is simple and rugged, the valve and hammer being the only moving parts. A simple tappet valve, actuated by a trigger conveniently placed on the handles, controls the operation of the machine. The length of the machine is 23½ in. and the insertion of a chisel bit, or other special tool, makes the overall length most convenient for a man of average height.

Thrust Boring Machine Used in Great Britain

For forming holes by the displacement and compression of the surrounding earth without the production of soil, the Mangnall-Irving thrust borer has recently been introduced in Great Britain. Features of this equipment are: Holes may be bored not only horizontally but in any other position and the boring tubes may be withdrawn at any point of the stroke; the 3-in. pilot is "pushed" while any enlarging is done by "pulling."

The borer, as illustrated, consists of a hydraulically operated crosshead working on parallel fixed piston rods which have jacking screws at each end. Thrust plates of large area, each embodying a lateral and vertical gear, are arranged at each end of the machine. Flexible pressure and return tubes connect the crosshead with the pump. All



of this apparatus, with the exception of the pump, is shown in the pit in the illustration. The pump is a hand-operated, high pressure machine, consisting of the pump mechanism mounted on top of a tank; it is fitted with control valve and pressure gage graduated to 1½ tons per sq.in. In connection with the latter, whenever the thrust tubes strike an obstacle the consequent rise in pressure indicates the fact very clearly.

All necessary accessory equipment is provided with this machine, consisting of simple surveying tools, enlarging heads of 4, 5, and 6 in. diameters, and other accessories. A case containing twenty 3-ft. boring tubes having special steel block ends that permit quick and rapid coupling and designed to take the full load in either compression or tension is supplied. This information was supplied by F. G. Bailey, 18 Upper Elmers End Road, Beckenham, Kent, England.

Lumber Carrier Machine Uses Hydraulic Lift

A machine designed especially for carrying lumber but adaptable for use in transporting many other kinds of material around a construction plant or warehouse is a new product of the Dalles Machine & Locomotive Works, Dalles, Ore. The running gears and the power plant are supported on the riveted steel frame which spans the load. The load is carried by shoes raised and lowered by means of four hydraulic cylinders. The motor is a

standard Fordson power unit equipped with a Bosch magneto. A three-cylinder plunger pump actuates the hydraulic cylinders which have a speed lift of 10 in. per second. Power is transmitted from the motor to the running gears through a roller chain drive. Oversize springs and heavy fork forgings are features of the design of this piece of equipment.

The carrying capacity of the machine is 12,000 lb. and it has a speed loaded of 15 miles forward and 10 miles reverse. Clearance inside for the load is 5 ft. high by 47 in. wide. The overall dimensions of the machine are 11½ ft. by 6 ft. All steel wheels and cushion tread tires are standard equipment.

Centrifugal Cast Iron Pipe Made in Refractory Mold

A new method of making centrifugal cast iron pipe has been perfected by the American Cast Iron Pipe Co., Birmingham, Ala., and a new plant to manufacture this product is now under construction; it is expected to be ready for full production by the middle of May. "Mono-cast" has been selected as the trademark name of this new pipe.

The mold in which Mono-cast pipe is made is a metal flask lined with molding sand. After ramming the mold with sand, it is placed horizontally in a centrifugal casting machine. The molten iron is charged, distributing itself along the bottom of the mold from end to end, when the casting machine is tilted. As soon as the point of proper distribution of this metal is reached, the spinning velocity of the mold is very suddenly and greatly increased. The resulting development of centrifugal force is to all practical purposes instantaneous. These forces cast the molten metal onto the wall of the sand lined mold and every part of the pipe is formed at the same moment.

It is claimed that this method of manufacture develops no internal casting strains in the pipe as has sometimes been the case in other methods of centrifugal casting; the refractory mold prevents the casting from being chilled. Further this new method of centrifugally casting iron pipe is claimed to give a true gray iron structure of a very fine grain size free of inclusions such as slag and other foreign materials, and that it shows 40 per cent better resistance to hydrostatic pressure than the ordinary sand cast pipe, 20 per cent greater value in cross bending, and 25 per cent greater value in withstanding shock.

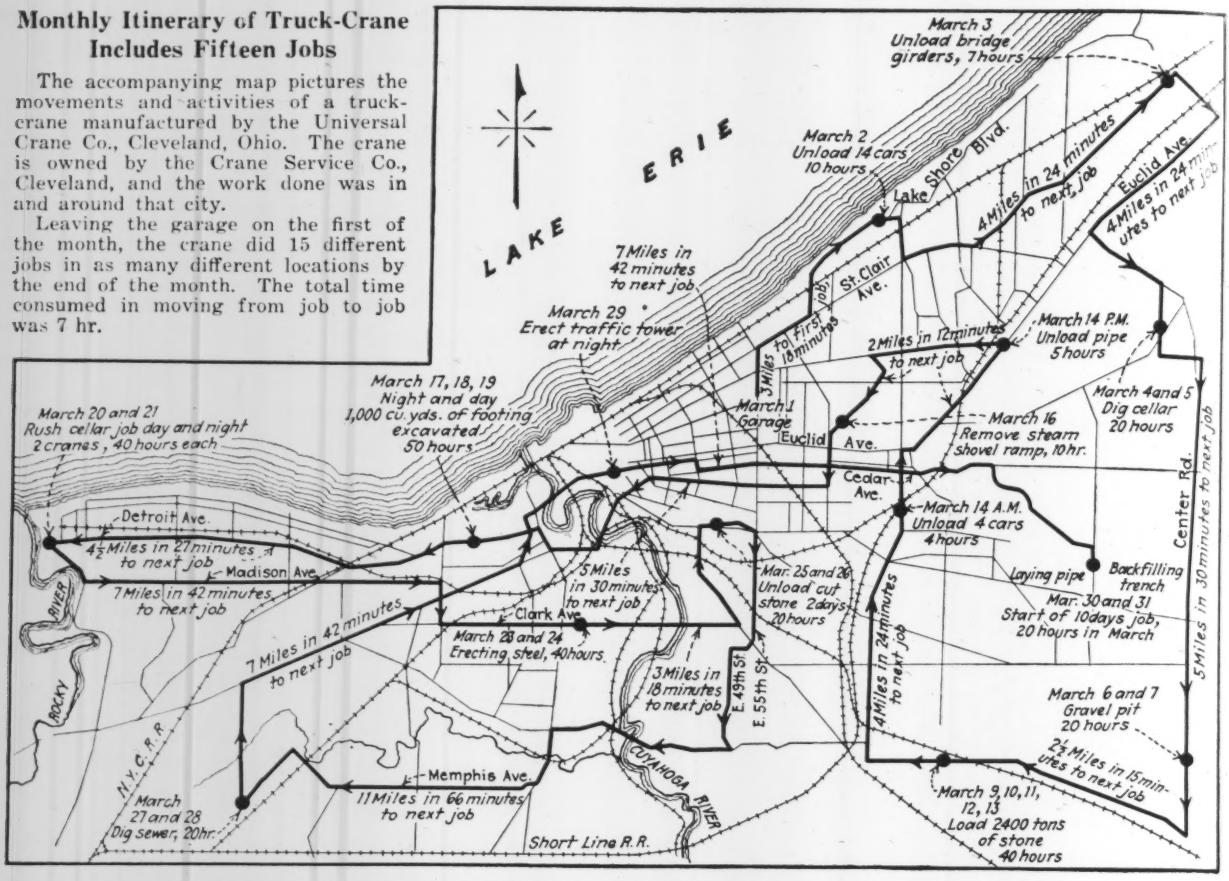
The specifications for this pipe are in complete conformity with the specifications of the American Water Works Association, the A.S.T.M., the New England Water Works Association and the American Gas Association.

The new plant will be capable of being operated 24 hours per day and having a nominal capacity of 50,000 ft. of Mono-cast pipe per day with a range of sizes from 4 to 12 in. inclusive. The pipe machines and all equipment connected with them are adjustable and interchangeable so far as pipe sizes are concerned, and any machine can be adjusted to handle any size pipe from 4 to 12 in.

Monthly Itinerary of Truck-Crane Includes Fifteen Jobs

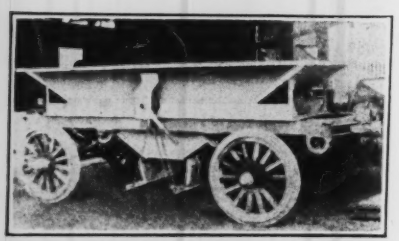
The accompanying map pictures the movements and activities of a truck-crane manufactured by the Universal Crane Co., Cleveland, Ohio. The crane is owned by the Crane Service Co., Cleveland, and the work done was in and around that city.

Leaving the garage on the first of the month, the crane did 15 different jobs in as many different locations by the end of the month. The total time consumed in moving from job to job was 7 hr.



Trailer Dump Bodies Designed to Spread Road Material

Center-dump steel bodies, which also spread the surfacing material on the roadway have recently been manufactured by the Western Pipe & Steel Co., Phoenix, Ariz., for the State High-



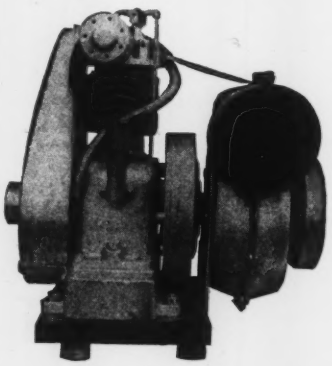
way Department of Arizona. These bodies are made interchangeable so that they may be mounted on either Troit or Detroit trailers, and are of 2½ yd. capacity.

Gasoline Engine-Fan Unit for Temporary Ventilation Work

A gasoline engine-fan unit made in two sizes, having capacities from 775 to 1,050 cu.ft. per minute and 320 to 430 cu.ft. per minute respectively, is a new product of the B. F. Sturtevant Co., Boston, Mass. This small portable equipment while designed primarily for ventilation of manholes, is equally suitable for a variety of other services which require a supply of air temporarily and where it is not convenient or possible to use motor-driven fans.

Owing to the comparatively large volume which this blower handles, it is particularly adapted to scavenging manholes in which gas has accumulated. When the foul air has been driven out, the volume which the blower handles may be reduced by regulating the speed of the engine, or by restricting the diameter of the hose, so that the blower delivers only the air needed for ventilation.

A single-cylinder, four-stroke, air-cooled engine is direct connected to the



fan and speed regulation is obtained by means of an adjustable governor. The gasoline supply tank is in the base of the engine and the magneto is contained in the flywheel, thus eliminating batteries and auxiliary tanks.

Publications from the Construction Industry

Hoist — J. S. MUNDY HOISTING ENGINE CO., Newark, N. J., devotes a new 40-page catalog to its line of light and heavy-duty gasoline hoists. Each type of hoist is illustrated and a description of its use on some current construction work is given, in addition to the details of construction which appear both in tabular and text form.

Automatic Buckets—HAYWARD CO., New York City, has recently issued two new bulletins, the first on its dwarf orange-peel buckets for such work as sinking cylinders and pipes from 12 in. in diameter up, cleaning sewer catch-basins, etc., and the second on Hayward buckets for sewers, roads and streets. Many construction illustrations of the buckets in use are given in the latter bulletin.

Electrical Equipment — GENERAL ELECTRIC CO., Schenectady, N. Y., has published much of its history during 1925 in a 62-p. booklet entitled "Some Developments in the Electrical Industry During 1925." The booklet describes and illustrates the developments made in the many lines of electrical equipment manufactured by the company. It represents an elaboration of the material published in *Engineering News-Record*, Feb. 18, 1926, p. 300.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Bank Debits in New York City and Outside

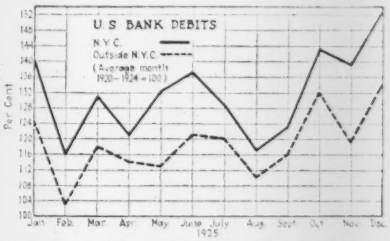
Similarity of Two Curves Indicates that Theory and Practice Still Differ

PROBABLY the most trustworthy index of business activity is the tabulation of debits to individual accounts, collected by the Federal Reserve Banks. In the first issue of each month *Engineering News-Record* has been publishing a chart showing the total debits this year as compared with last year.

Just what bank debits are and their relation to bank clearings are fully explained by George B. Roberts in *Engineering News-Record*, April 23, 1925, p. 710. "These figures," he writes "while rather formidably named, are nothing more than the charges reported by banks against customers' deposits as the result of checks or other payments."

Statisticians generally hold that the volume of bank debits outside New York City is a more accurate index of the country's activities than are the total figures. They say that a considerable proportion of the buying and selling on the New York stock exchange finds no reflection outside the City.

The accompanying chart compares the trends of bank debits in New York with those of the rest of the country in 1925. The characteristics of the two



curves could hardly be more similar without being identical. The chief departure occurs in May, when New York City debits rose sharply while the figures for the rest of the country fell slightly. In June, however, they rose together at nearly the same angle.

The curves serve to tie up what is generally believed to be, with what actually is.

Demand for Lumber Greater Than in 1925

The output of the nation's lumber mills for the first thirteen weeks of the current year is 3 per cent ahead of the corresponding period in 1925; shipments on old orders are 7 per cent and unfilled orders, 14 per cent greater. This would indicate a continuation of the present volume of frame construction.

Southern pine mills are shipping at a rate greater than production, thereby affecting reserve stocks, while demand also shows a volume greater than the output. West Coast mills are producing slightly more than they ship with consequent accumulation of reserves, while orders are as far ahead of output as is the case in the Southern pine districts. Prospects of a price advance are greater in pine than in Douglas fir or other Western lumber.

Record Steel Output Leaves No Surplus Stocks

Orders on books of the U. S. Steel Corporation, Mar. 31, totaled 4,379,935 tons, compared with 4,863,564 tons on the same date last year. The output of steel ingots, all companies, as calculated by the American Iron and Steel Institute, was 4,491,689 tons for March as against 4,198,520 for the corresponding period in 1925. This constitutes a record month in steel production.

The fact that cancellations of orders are almost absent from the market and also that no excess reserve stocks are reported among manufacturers and dealers, would make it appear that this tremendous tonnage is going directly into the industries.

With prices holding steadily, the present position of the steel industry, as a whole, does not indicate impending depression. Current steel demand, although slightly below a year ago in actual tonnage is pursuing exactly the same course as in 1925. Last year, demand started to recede in March and slumped steadily until September, 1925 after which time orders gained gradually until January of the current year.

Unfilled Orders on Hand—U. S. Steel Corp.

	Tons		Tons
Jan. 31, 1926,	4,882,739	Jan. 31, 1925,	5,037,323
Feb. 28, 1926,	4,616,822	Feb. 28, 1925,	5,284,771
Mar. 31, 1926,	4,379,935	Mar. 31, 1925,	4,863,564

Steel Ingot Output—All Companies

1926	Tons	1925	Tons
January	4,153,545	January	4,198,564
February	3,804,594	February	3,756,243
March	4,491,689	March	4,198,520
3 months	12,449,828	3 months	12,153,327

This Week's Special Tabulation of Unit Prices

2. *Waterproofing for Subways*

These unit prices were included in the low bidders' estimate on various sections of New York subways from 1922 to date:

Material	Nov. 1922	Jan. 1923	Oct. 1924	Feb. 1925	Sept. 1925	Nov. 1925	Jan. 1926	Mar. 1926
1 ply, sq.yd	$0.80	$0.75	$0.60	$1.00	$1.25	$1.50	$1.25	$1.00
2 ply, sq.yd	.....	1.25	.....	.....	.....	.....	.....	.....
3 ply, sq.yd	1.55	2.00	2.50	3.00	2.50	2.50	3.00	3.00
4 ply, sq.yd	.....	2.00	3.50	3.50	.....	.....	.....	4.00
5 ply, sq.yd	.....	2.50	.....	.....	3.50	5.00	4.50	.....
6 ply, sq.yd	2.80	3.00	6.00	5.00	4.00	6.50	5.50	6.00
Brick and asphalt mastic	38.50	42.00	48.00	50.00	60.00	55.00	50.00	45.00

Next Week—Wood Block Paving

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
April 15, 1926	$22,240,000	$39,116,000	$61,356,000
April 8, 1926	19,191,000	38,080,000	57,271,000
April 16, 1925	10,778,000	21,051,000	31,829,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	259,947,000	508,798,000	768,745,000
1925	251,788,000	381,119,000	632,907,000

Weekly Construction Market

ENGINEERING construction contract letting, Jan. 1 to April 8, was 16 per cent ahead of the same period in the record year 1925, according to *Engineering News-Record* statistics. During March, records were achieved in steel ingot production, bank debits and car loadings. All of this, however, represents past history, since most of the steel was on orders previously placed, the check transactions covered goods received or services rendered, and much of the freight has already been consumed. The gain in contract letting shows that this year, thus far, is ahead of last. Buildings gained 22 per cent and other construction, 5 per cent compared with the first fourteen weeks of 1925. The recent stock market deflation followed by a lowering of money rates reveals a growing lack of interest in borrowing and investment for the further expansion of trade and industry.

The construction outlook for the next three months at least, is better than that of a year ago to date. Work definitely reported as proposed, which shows more than building permits alone, reveals a gain of 20 per cent in buildings and 11 per cent in construction other than buildings, for the period Jan. 1 to April 8, this year compared with last. This increase in prospective work is scattered throughout the entire country. There is little likelihood of important price advances developing at any of the principal industrial centers in the near future. New York bricklayers are signed up for three years at $1.75 per hr., an advance of 25c. over the old rate. Barmen on demolition work received an advance of 12½c. per hr. over the old rate of $1.05 and laborers in these operations, 10c. per hr. over the former wage of 95c.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.40	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.50	3.50	4.75	3.50	3.75	4.65	5.00	3.75	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.77½	3.20	3.25	2.30
Steel pipe, black, 2½ to 6 in. lap, discount	48%	+44.3%	53.6%	51%	54.25%	36%	39.2@51%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@52.60	+46.35	54.00	49.20@50.20	53.00	64.00	52.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.25
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.50
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	41.00	37.75	34.75	27.00	25.00	65.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.50	+2.25	2.25	1.35	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.50	10.50	+12.00	12.00	14.25	12.00	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0977	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1112	.0977	.10	.075	.076	.075	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	.83¼	—.90	1.13	.85	.96¾	1.06	.96	1.12	1.10
Common Labor									
Common labor, union, hour	.62½@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.55	.35@.50	.50	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 1, the next on May 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par.) Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money quoted at 4@5½ per cent, Apr. 12; year ago, 3½ per cent.

Time loans: sixty-ninety days, 4⅜; four-six months, 4½ per cent.

Commercial paper: best names, 4¼@4½ per cent; other names, 4¾ per cent.

On April 1, 1926

E. N.-R. Construction Cost Index Number 207.05

E. N.-R. Construction Volume Index Number 240

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month